TENTH ANNUAL REPORT

OF THE

Ohio Society

OF

Surveyors & Civil Engineers

BEING THE

TRANSACTIONS OF THE SOCIETY

AT ITS

TENTH ANNUAL MEETING

Held in Columbus, Ohio, January 8, 9 and 10

1889

V. D. A.

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AND OTHER VALUABLE MATTER

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H. C. WHITE, - - - - Warren, O.

SECRETARY,

C. N. BROWN, - - - - Columbus, O.

TREASURER,

F. J. SAGER, - - - - Columbus, O.

BOARD OF TRUSTEES.

THE OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS, as a body, is not responsible for the statements and opinions advanced in any of the papers published in this report.

TENTH ANNUAL REPORT

OF THE

OHIO SOCIETY OF SURVEYORS

—AND—

CIVIL ENGINEERS.

The Tenth Annual Meeting of the Ohio Society of Surveyors and Civil Engineers was held in Lyndon Hall, Columbus, Ohio, on January 8, 9, 10, 1889.

The Society was called to order at 2 o'clock P. M., by President J. D. Varney.

The exercises of the meeting were conducted essentially according to the following

PROGRAMME:

Tuesday, January 8, 9 A. M.

Meeting of Trustees and Committees and Arranging of Displays.

Afternoon. — 1:30.

Report of Secretary.
Report of Treasurer.
Report of Trustees.
Election of Members.

Report of Committee on Code.—B. F. Bowen, *Chairman*, Columbus.

*Report of Committee on Legislation.—A. R. GEYER, *Chairman*, Paulding.

Address of President.—J. D. VARNEY, Cleveland.

Evening — 7:00.

PAPER.—Limes and Cements of Ohio.—DR. EDWARD ORTON, Columbus.

*PAPER.—Limes, Mortars and Cements.—W. A. GINN, Sidney.

PAPER.—Water Supply.—H. F. DUNHAM, Cleveland.

Report of Committee on Highways.—E. W. DIMOCK, *Chairman*, Ottawa.

Wednesday, January 9, 8:30 a. m.

Report of Committee on Civil Engineering.—C. A. JUDSON, *Chairman*, Sandusky.

PAPER.—Street Pavements.—SAM HUSTON, Steubenville.

PAPER.—Pile Protections.—J. A. PRITCHARD, Darbyville.

PAPER.—Gravel.—JONATHAN ARNETT, London.

Afternoon — 1:30.

*PAPER.—Creeping of Rails.—H. A. KENNEDY, Engineer of Cleveland & Canton Railroad.

PAPER.—Electric Railway Signals.—JOSEPH T. WHITNEY, Columbus.

PAPER.—Cemetery Engineering.—JOHN L. CULLEY, Cleveland.

Report of Committee on Land Surveying.—J. B. STRAWN, *Chairman*, Salem.

Evening — 7:00.

PAPER.—The Importance of Properly Making Surveys.—HOMER C. WHITE, Warren.

*PAPER.—The Sub-division and Platting of Town Lots.—GEORGE MCGORMLEY, Tiffin.

PAPER.—The Indexing of Drawings.—JOSEPH N. BRADFORD, Columbus.

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*Not read.

Thursday, January 10, 8:30 a. m.

Report of Committee on Drainage.—E. B. OPDYCKE, *Chairman*, Bryan.

PAPER.— Description of Sewer.— H. L. WEBER, Bucyrus.

PAPER.—The History of a Ditch.—F. M. DAVISSON, West Manchester.

Afternoon — 1:30.

Report of Committee on National Public Works.—W. H. JENNINGS, *Chairman*, Columbus.

Report of Committee on Blanks and Instruments.—J. KINNEAR, *Chairman*, Columbus.

Unfinished Business.

New Business.

Election of Officers.

Discussion after each Paper, and all present are invited to participate.

TREASURER'S REPORT.

COLUMBUS, OHIO, January 8, 1889.

To the officers and members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN:—I herewith submit the following statements of the receipts and expenditures of the Society during the year 1888, as follows, to-wit:

Received from the sale of reports	$ 19 18
Received from membership fees	66 00
Received from annual assessment	268 62
Received from advertisements	180 00
Total amount collected in 1888	$533 80

Expenditures were as follows:

Salary for Benjamin Thompson, Secretary, for two years, as directed by resolution of Society	$100 00
Hann & Adair, printing 1,200 reports of annual meeting	475 41
Fees of stenographer	22 00
Stationary	30 12
Expressage	19 21
Postage	22 90
Copying press	8 20
Blackboard	5 25
Painting sign	1 60
	$684 69
Deficiency	$150 89

Respectfully submitted,

F. J. SAGER, Treasurer.

Secretary's Report.

To the members of the Ohio Society of Surveyors and Civil Engineers:

Gentlemen:—Your Secretary respectfully submits the following report: Immediately after the meeting arrangements were made with Messrs. Hann & Adair for printing 1,200 copies of the report, in the usual size and style.

Exchanges have been made with the following societies:

Association of Provincial Land Surveyors.

Association of Dominion Land Surveyors.

The Arkansas Society of Engineers, Architects and Surveyors.

The Missouri Association of Surveyors.

The Illinois Society of Engineers and Surveyors.

The Michigan Engineering Society.

The Indiana Society of Surveyors and Civil Engineers.

The American Society of Civil Engineers and the Engineers' Society of Western Pennsylvania send us their proceedings, and so copies of our report were sent to them. Copies were also sent to the engineering papers and the State Library.

The edition of the Eighth Annual Report is exhausted, and if any of our members have extra copies, the Secretary would be pleased to know of them, as calls are sometimes made for them.

The Secretary, as Officer of the Bureau of Information, can report but little work done. But two persons filed applications, and in but one case could help be given.

Mr. Hodgman has presented the Society with a copy of the new edition of his most excellent Manual of Land Surveying.

During the year another of our members has passed away, Mr. W. S. Cunningham, of Marion, who had always been a valuable member of our body.

Respectfully submitted,

C. N. Brown, Secretary.

REPORT OF BOARD OF TRUSTEES.

To the officers and members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN:—Your Board of Trustees, whose duty in part is to examine the books of the Treasurer of the Society, would respectfully report that they have attended to that duty, and find that they have been correctly kept. We have also fixed the assessment per members for the year 1889 at $3 00. We also recommend for members those persons whose applications are attached.

We feel that the thanks of the Society are especially due to our Secretary, C. N. Brown, and our Treasurer, F. J. Sager. In view of the low condition of the finances in the treasury, they have declined to receive any compensation for their services during the past year.

Respectfully submitted,

W. H. JENNINGS,
WILLIAM REEDER,
C. A. JUDSON,
F. M. DAVISSON.

President's Address.

Another year has come and gone. Ten years since the formation of our society, and again we come together to clasp hands, to look in each others' faces, talk over the past and prepare for greater usefulness in the future. A year, a day, ten years, a century. With what vast consequences the least may be fraught. How meagre sometimes seem the results of the longest life.

It is a scientific as well as a poetic conception that life consists of heart beats and activities.

It is only in comparing motions that we get a conception of time. It is only for convenience that we have adopted the earth's motions as units by which to measure other motions. Heart beats and other activities of mind and body are the real measure of the lives of individuals and the race.

He who grasps and enters into the activities produced by the railroad, the telegraph and the telephone, lives in the same number of days hundreds of times longer than the savage whose activities are bounded by the industries connected with the chase.

He who improves on a method of performing work and renders possible more, or better service for the same expenditure of force, adds to the absolute sum of human life.

If he deserves immortality of life and fame, who causes two blades of grass to grow where only one grew before, then also does he who improves human methods, for, in the last analysis, all improvements finally express themselves in increasing the capacity of the earth to sustain human life.

This statement may not be accepted, and sustaining arguments would be out of place here, but, being accepted, it ennobles all honest effort in ours as well as in other callings, for to save life is ever a praiseworthy act, and he who by his hand or his brain has added to the utility of human effort, has by that act as really saved life as he who on the battle field turns aside a sabre point.

As to what we have been doing during the year, you are referred to the reports of the several committees.

The correspondence which I have had with the other members

has shown, both by statements made and by silence, that the season has been a very active one.

Early in the season I planned to make this a memorial meeting at which we should have an exhibition of the instruments and work of the past, with which to compare the tools and the work of the present, but the labor of preparing such an exhibition seemed to be more than we could spend time for, and so I was forced, though reluctantly, to abandon the project.

Such an exhibition would doubtless have been a valuable lesson to us, and I trust we would have been wise enough to learn the lesson.

If we had simply congratulated ourselves that we are doing better work than our predecessors, the lesson would have been worse than wasted, but I doubt not we would have appreciated the fact that relative merit lies not in the amount or quality of the work we do, but that it lies in the use we make of the facilities we have, and recognizing this, such an exhibition would doubtless have made us modest in our claims for approbation.

We should adopt some simple method of relieving our books from the names of those who do not care to remain members. The reports should be sent only to those who have paid up in full. When a person is a year or more in arrears, they should be notified, and if they fail to pay within some specified time, let their names be dropped from the books.

For the interests of the public and the profession, we need a modification of the statutes of the State relating to the making and recording of plats of subdivisions, and for the protection of monuments.

If the statutes of the State provide for subdivisions disconnected with municipal corporations, it is only by an implication so obscure that good lawyers doubt its existence. We should have a law so framed that there would be no obscurity or uncertainty, giving any person the right to have a plat recorded showing his land in one or more lots, from which to sell the same, with the governing monuments, and providing under proper conditions for the protection of the monuments.

While on the subject of proposed legislation, there are some

facts and reflections on legislation in general, it will be well to consider.

It is quite common to hear expressions made, the purport of which is, that there is no use trying to get a law passed unless some one is going to make enough out of it so they can afford to spend considerable money for the purpose.

This is probably true, and yet it does not necessarily imply dishonesty on the part of legislators, or those who ask legislation.

The difficulty lies right in the circumstances or nature of the case, and is not brushed away by accusing people of acting from improper motives. We have no right to expect any man who is not paid for doing it, to spend his time to do the work required to prepare and present a law to the Legislature, and supply committees with the reasons for passing it, and to answer the objections which are sure to be brought to the most wisely framed law.

It is a serious matter to amend our laws, and should only be attempted after a careful and painstaking study of the situation, and how shall the people pay for the necessary labor? True, the members of the Legislature are paid for their services, but they cannot be expected to have a technical knowledge on all subjects, and it is quite probable that they are performing their most valuable service to the people when they are defeating unwise legislation, and we have no right to expect of them that they shall originate and carry through new laws relating to technical subjects. It may not seem gracious to point out difficulties and then fail to point out a remedy, but it is sometimes the highest good within our reach to learn where we are and what difficulties confront us, and it is seldom that we wisely act until we have become somewhat humiliated by a recognition of the full importance of our difficulties.

Certainly, wise laws for the public good have been enacted in the past, and probably will be in the future Societies like this may be utilized for the purpose, but after all, even then it only changes the form, but not the nature of the case. The work must be done by individuals who feel the importance of it.

There is one subject agitated among us which it is desirable that we should discuss frankly, fully and freely. I refer to the

movement which comes up in various forms, but which may briefly described as an effort to protect the profession from practice by incompetents by legislative enactments.

It is interesting to notice how history repeats itself in certain types of movements, though with varying forms.

My reading as a historian, or as a naturalist, has not been very extensive, but I once listened to a course of lectures by the late Prof. W. D. Gunning, who talked of such things with a familiarity which gave the impression that he was born and educated in that far off time before animal life had commenced on the earth, and had watched its slow growth through the countless ages since, and therefore might be safely taken as authority on any questions concerning nature's handiwork, and he tells of a time when animals of a certain order conceived a brilliant notion of covering themselves with a shield to protect their bodies from their enemies.

Whether or not they protected their invention by letters patent, Professor Gunning did not say, but probably not.

It is quite probable that the invention was kept within the family of the inventors, as some of the Swiss watchmakers protect their industries, by making the process by which the result is produced a family secret. Whether so or not, the process certainly is a secret, and the monopoly has come down to our time in the turtle and armadillo families.

Whether or not there was ever a serious attempt among the earlier animals to infringe upon the patent, or to surreptitiously obtain the secret, Prof. G. did not say, but whether so or not, for many ages the attitude of the other animals has been the same as that of the fox towards the "sour grapes."

They did not care for it, and the nearly unanimous opinion has been that such a shield may do well enough for those who lead such unambitious lives as turtles lead, but for those who wish to move in good society, and keep up with the times, it is an inconvenience without corresponding benefits.

In later times, another family came upon the stage. A sort of early edition of the Yankee. A family full of schemes, and inventors of new methods, among which, was walking on their hind feet, and wearing their heads on the top of the body.

This animal evidently had but little respect for vested rights or family secrets, and conceived the brilliant notion of infringing on the turtle invention.

The secret had been so well kept that no attempt was made to adopt the method of construction, but the idea was adopted and carried out in several forms. One was with a shield to be carried on the left arm; another was a metallic covering for the body; but the history of this movement was the same as that of the first invention. Improved offensive appliances kept pace with the strength of the shield.

As the armor was made heavier, inventive genius increased the penetrating power of offensive weapons, and as the Glyptodon, having secured a strong shield, covering his entire body, was so encumbered by it that he himself became only a fossil, leaving as his successors and base imitators, the slow going armadillo and turtle, even so the armor of the knights became so cumbersome as often to place the wearer at the mercy of less weighted foes, and shirts of mail, helmets and shields are now relegated to [redacted]

During our late war of the rebellion, there was another movement on the same line, in the construction of iron clad gun boats.

The history of this movement was but a repetition of preceding movements.

Plates of steel were added, ever increasing in thickness, each in its turn penetrated by offensive ordinance, which was also improved as the armor was increased, till the same old result was reached, and again it was learned that added armor is added encumbrance; that the swift sailing vessels, the active little torpedo boats and long range guns are the lines on which effective warfare is to be conducted, demonstrating that however it may be in the race, the battle is to the swift.

In the pursuits of peace, we are evidently now in the incipient stages of a movement along the same line, manifesting itself in the formation of trusts and other combines, and efforts to secure legislative enactments, which, being put forward in the name of the interests of the "dear people," are really only defensive armor which different professions and classes of workers are trying to fix

upon themselves, hoping thereby to shield themselves from the competition which is sure to come and to sweep around and override all merely defensive devices, and to carry down all who waste their energies in cumbersome and obstructive armor.

These movements in the peaceful pursuit are only now in their opening stages, and trusts, combines, labor unions and defensive legislation seems to be a panacea for all of human ills, and in the full tide of local and temporary prosperity in some quarters, all seems to go "merry as marriage bells."

The manufacture of one after another of the commodities of the country is passing under the control of their respective trusts, and millions are being poured into the coffers at the respective centers.

The doctors have hedged their profession about with such safeguards that it is difficult to get ourselves killed in any other than regular scientific methods.

If we take prussic acid from a druggist when we had only planned for a slower suicide with diluted fusil oil, in our dying moments we have the satisfaction of knowing that the error was made by one who was duly licensed to make the blunder.

Laborers in each field are trying to control as to who and how many shall compete with them, some of them going so far as to limit the number of apprentices in their trades, while the employers of labor combine to shut out competition in the products.

The farmers have nearly succeeded in suppressing the use of oleo, and are happy with butter ranging among the 40's, and the civil engineers and surveyors, catching the infection and growing restive, are manifesting a disposition to tone down their own friskiness by taking on a load of armor as a method of working off their superabundant strength.

No! No! Many times, no!!

In that direction our true interests do not lie. It is not courageous to fear competition from incompetent men, nor is it wise to try to attempt, through the Legislature, to supply brains for those who are unwise enough to employ them. If we can do anything as individuals, as a society, or through the Legislature, which shall increase our efficiency or increase the field in which we may work, then we are promoting our own as well as public in-

terests, but when we attempt to prevent others from working, we are wasting our energies, besides acting in an unjustifiable manner. Though it is not good judgment (to use no stronger term) to use armor of any kind to protect ourselves from competition, which in one way or another we must contend with, it is advisable for us to try, by all legitimate means, to penetrate and destroy the armor which others have constructed and are using to prevent us from working in our legitimate field. I refer to the barriers which have grown up around, and which are thought to be in the interest of army engineers, the effects of which are to improperly discriminate against the civil engineers in the services required on national public works. Here is a field in which united action can be made useful to strengthen the hands of the Council of Engineering Societies, who are making strong efforts, not to put on armor or to erect barriers, but to penetrate an armor and break down barriers which stand between us and a large field of activities in which we insist we should have the right to work in proportion to our qualifications, and, though the present state of things is supposed to be in the interest of the army engineers, there is no one who would more heartily welcome the change than some of the broad minded army engineers themselves, who know as well as any one does, that the highest good of all parties comes from a fair field and no favors.

For information as to what the Council and what our Society has done and is doing in this matter, you are referred to the report of Mr. Jennings, the Chairman of your Committee on National Public Works.

Printing and Disposal of Reports.

On motion, it was ordered that the Secretary have printed such a number of Reports of this meeting, and that he exchange with such other societies as he may deem best. Also, that he distribute to each member of this Society one copy, to each advertiser one copy, and to each officer and person preparing any paper or report published therein, three copies of his Report.

Also, that any member of this Society, upon making application to the Secretary at any time before the Reports are printed, shall have, upon payment of net cost price, such number of additional copies of the Reports, or papers therein, as he may desire.

Communications.

Letters and telegrams were read from absent members. A vote of thanks was tendered to Benjamin Thompson for his interesting and valuable letter to the Society.

Vote of Thanks.

The thanks of the Society were tendered to all persons making exhibits at the meeting, or donations to the Society, and to all persons not members of the Society, who have prepared papers for this meeting, and also to the outgoing President, and the Secretary and Treasurer.

Miscellaneous Business.

Upon motion, a committee consisting of President Varney, Messrs. Strawn and Jennings, was appointed to report upon the advisability of changing the time of our annual meeting from January to December. The committee reported that the change was not desirable when all circumstances were considered.

A cordial invitation to their meeting was received from the Ohio Institute of Mining Engineers.

Mr. Griggs made a report for the members residing in Columbus, who formed a Committee on Exhibit at the Centennial held in Columbus during the past fall. The committee had found it impossible to make a Society exhibit, but had induced several manufacturers to make exhibits of engineering instruments and supplies.

Mr. Jennings made a report in regard to the formation of a Columbus branch of the Society. A society has been formed, but not as a branch of this Society. An invitation was extended to all our members to attend their meetings.

The Secretary read a communication from the Indiana Society of Surveyors and Engineers, submitting the question of the feasability of establishing a uniform standard for the minimum dimensions and strength of bridges. The matter was fully discussed, but the general impression seemed to be that the thing proposed was too full of difficulties to be carried out.

Report of Committee on National Public Works.

GENTLEMEN—Your committee sent the following circular to each of the members:

DEAR SIR—With each package of Reports sent to members this year, was enclosed a copy of the pamphlet—"Reorganization of National Public Works"—giving an account of proposed legislation—*i. e.*, the Cullom and Breckenridge Bill, creating a National Board of Public Works analagous to those that obtain with European governments. By the present system of our Government, the charge of our public works rests with the military engineers, allowing no advancement to civilians. The new bill proposes to obviate this difficulty. The Council of Engineering Societies has for some time past maintained a committee to push the passage of this bill. Our Society has taken part in the proceedings of the Council, having had a committee each year to confer with this joint committee.

The amounts necessary to push the matter are raised by assessments on the members of the different societies. Our Society is recorded as having 120 members, and the sum of $1.00 each has been assessed by the joint committees, and as our Constitution makes no provision for this, it becomes necessary to make a personal appeal to each member.

We, as a committee of the Ohio Society, ask that you forward to the Chairman, as below, the sum of $1.00 to meet this assessment.

Our Society has been acting with this movement, and it now becomes necessary for us to render the support asked for.

Very truly yours,

W. H. JENNINGS,
BENJAMIN THOMPSON,
C. A. JUDSON,
Com. Board of Pub. Works.

W. H. JENNINGS, *Chairman*,
Columbus, Ohio.

In response to this appeal for contributions, twenty-two persons have sent $1.00 each to the committee.

Should there be any others desiring to contribute to this cause, the committee would be pleased to accept their offering, which need not be limited to $1.00.

It has been suggested that the money contributed be sent to the Treasurer of the Council of Engineering Societies by our Secretary, with a letter stating that the money comes from individual members of this Society, to aid the cause for which they are working; that our Society is not strong financially, and that we hope they will accept the sum, even if it is small, and that our good wishes are ever with them in their work.

Respectfully,
W. H. JENNINGS,
CHARLES A. JUDSON.

President Varney: I will add a little to that report, perhaps unofficially. I have learned from one of the prominent members of the National Committee that that committee is now working earnestly and zealously; that there is a representation of the association in Washington, and will be there this winter, and that they are doing the best they can, and hope to make material progress. I had hoped, and they had hoped to have a report sent to Mr. Jennings, giving exactly what they had done, but they were not in a position at this time to make their work public. However, we may depend upon it that such men as Mr. Cooley and Mr. Davis, and other members, are not idle. They are working, and should be sustained.

Time and Place of Eleventh Annual Meeting.

The eleventh annual meeting of the Society will be held in Columbus, Ohio, January 14, 15 and 16, 1890. Announcement of the place and meeting will be made in December preceding.

Members are especially urged to keep in mind that a programme, fully as good, or better, than the last must be presented at that meeting, and a successful meeting can only be assured by each and every one taking an active interest in the work of the Society, and assisting the officers and committees in the preparation of that programme.

At all times during the year, suggestions, queries, problems, and willingness to bear a share of the responsibilities, will greatly encourage those who are nominally at the head of affairs.

Election of Officers.

On motion, a committee, consisting of Charles A. Judson, E. D. Haseltine and W. H. Jennings, was appointed to nominate officers for the ensuing year.

The committee recommended the following members for officers for the ensuing year, all of whom were unanimously elected:

For President—B. F. Bowen, Columbus, Ohio.

For Vice-President—Homer C. White, Warren, Ohio.

For Secretary—C. N. Brown, Columbus, Ohio.

For Treasurer—F. J. Sager, Columbus, Ohio.

For Board of Trustees—J. D. Varney, Cleveland; Julian Griggs, Columbus; John Harvey, Wilmington; J. M. Harper, Cincinnati; H. B. Vanatta, Nelsonville.

for the public good. Another is in laying of a foundation extremely beneficial to our association or the members of it. In that view, however, it is the most vital part of the discussion. The most important thing that we need do when we go home is to make our best efforts to get on the warm side of the County Commissioners, and then determine the method of making the map after we get the job, because there is where it comes in. The Commissioners determine this matter. Our Auditor was instrumental in getting the law passed; a very excellent man. He induced the Commissioners to advertise for proposals to make the maps of the county, the city and villages in a way that was satisfactory to himself. They got proposals ranging from $2,500 to $13,000—a pretty wide margin. The Commissioners, in their judgment, threw out all the bids and employed a draughtsman to make up a set of maps, and that is the way the maps were produced in this county. They were made on sheets, no books at all, and of a scale to suit the circumstances, and according to the size of the territory that the appraiser was working on. Taking it altogether, I do not think the expense in making the maps the way they were made would exceed seven or eight hundred dollars. The maps were delivered to the appraisers, and used in making the assessment. In this work the map was pretty generally consumed. Some were returned to the Auditor's office, and some were not. I do not think the maps were ever filed or kept for any future use. The records were put on the books, the usual way, and carried along.

Mr. Buck: In our county (Morrow), we had maps ten years ago, and the Commissioners gave me the contract of making them. They were made thirty-five by forty inches, and I made duplicates of these upon excellent paper, showing the names of all the owners of lands, roads and areas, sections, etc. Part of ours are Military and part Congress lands. The townships were drawn upon a scale of about eighty poles to the inch, towns and villages about ten poles to the inch. The Auditor requested me that wherever I knew there was more land than what the different tracts were charged with, to insert the amount on the plat, which I did, and I think that county is now paying taxes upon a great many more acres than they were before. I know there were some

eighty acres that run four or five acres over, and I remember one section where they were paying taxes on 160 acres, where there was 175 acres in the piece.

Mr. Alten: I would like to know whether we have any right to deviate from the quantities given by the Government surveyor? The pieces will sometimes overrun or fall short. If we have a right to tax them where they overrun, we also have a right to cut them where they fall short.

The President: In our county, where the pieces fall short they take it off, but they do not mention it where it overruns.

Report of Committee on Code.

The "Code," as here used is understood to mean the Code of Rules for County Surveyors provided for in Section 131 of the Revised Statutes of Ohio.

In land surveying, there is no conflict with the fundamental principles involved in that science, the accepted theory being invariably the same. To produce the best results, our practice should also be uniformly the same under like conditions. With this view the Legislature of Ohio, in 1846, passed a law requiring the Secretary of State to prepare a Code of Rules for County Surveyors.

At that time the Secretary of State was the legal custodian of all the public records pertaining to the land of this State, and it would therefore seem eminently proper for the "Code" to issue from that office.

In 1877, the Legislature passed a law transferring the public land records from the office of the Secretary to the office of the Auditor of State. The law making the transfer of said land records did not carry with it to the Auditor of State the duty of issuing a code of instructions to county surveyors. Section 5, of the same act, however, provides:

"That the County Surveyors within this State, in the discharge of their duties, shall be governed by the Code of general rules and instructions prepared and published under the provisions of the act passed February 24, 1846," above referred to.

In the general revision of the statutes of Ohio, in 1880, in defining the duties of the Secretary of State, Section 131 provides that

"He shall prepare a Code of Rules or Instructions for County Surveyors, which, when approved by the Governor, shall be printed, and a copy thereof furnished to each County Surveyor, who, and their successors in office, shall be governed by the same in the discharge of their duties. These rules may be revised and

re-published and furnished as aforesaid, when necessary, and when approved by the Governor, shall supersede those before furnished."

This section of the law is imperative on the State official, and its respect and observance is equally mandatory on the County Surveyors.

It is generally believed to be an error to place this duty on the Secretary of State at present, when it so manifestly belongs to the Auditor of State, who is now the custodian of all the data and records of the public lands of the State.

The revision of the Code should rest with the State Auditor, who could put the details of the work in the hands of his deputy having charge of the public land records, or a special deputy. The work, when completed in manuscript, should then be examined and if found worthy, should be approved by the Governor, Attorney General, and the Professor of Surveying and Civil Engineering of the Ohio State University, and should also have the approval and endorsement of the Ohio Society of Surveyors and Civil Engineers.

This very general criticism and approval is recommended with a view to eliminate all the errors possible, and make the "Code," when revised, a complete standard of practice.

To this end, we recommend that the Committee on Legislation confer with the members of the present Legislature with a view to have Section 131 of the Revised Statutes so amended that the duty of Revising the Code of Rules for County Surveyors will in the future devolve upon the Auditor of State.

When this preliminary has been arranged, the work of revision should be commenced at once, and prosecuted as above suggested.

B. F. BOWEN,
Chairman Committee on Code.

Report of Committee on Land Surveying.

Historically, the year just closed has been one of more than usual interest to the citizens of Ohio. It has been a kind of Jubilee year for the "Buckeye State." We shall not attempt to give a description of the wonderful improvements made within our State in the one hundred years now ended.

In imagination, we look back one hundred years; and as one of the forerunners of the early pioneers we find the surveyor, clad in homespun or buckskin, heading a little party of sturdy yeomen similarly clad. A surveyor's outfit consisted of an open-sight compass, Jacob-staff, a two-pole chain, marking pins, either of wood or iron, a supply of quill pens, a small pocket ink stand, composed of lead, paper, etc. The land that he surveyed and marked then is now the home of the thrifty farmer, or the site of some beautiful city, with its hundred thousand inhabitants, with its metropolitan society and improvements.

To-day we find another surveyor on the field. He is engaged in retracing and monumenting old lines, subdividing original tracts, laying out towns and cities, surveying railroads and improved highways, draining swamp lands and irrigating dry lands, filling up low lands and the leveling of hills and high lands. He plants monuments, and makes witnesses to mark and prove his work. He proves his courses by the stars. He likewise goes through the hills, and under our rivers, and at his touch the rocks and hills do tremble.

What his work shall be one hundred years hence—who can tell?

We wish here to notice the improvements made in the instruments used by the land surveyor, who is no less a civil engineer, in very many instances.

The old plain open-sight compass has been superseded by the surveyor's transit; the former graduated to half degrees, the latter to half minutes and to minutes, with finely adjusted telescopes of various magnifying powers, suited to the various grades of work

with which the surveyor has to do. The heavy, cumbersome chain, which was *ever getting longer* has almost passed out of existence, or been supplanted by the steel lines, and steel and brass tapes. In place of a rough sapling being used for a sight-bole, we have our finely made rods, painted in appropriate colors, with true steel points; and now last, and possibly least, the patent tack to center our stake, with an indenture for the point of the sight-rod. The improved instruments for use in the office are also in keeping with those used in the field.

The surveyor of to-day should do better work than the surveyors of one hundred years ago. Does he? As a rule, yes. Even then lines were run and monumented which will favorably compare with our recent practice with our most approved instruments; probably better than would be done by us, if we were required to use the primitive instruments of our forefathers.

It is a great misfortune to our State that more of the early surveying had not been better done. It is probably true that the character of our early surveys, and for that matter many of our later surveys, has formed the foundation for the rulings of our courts, viz.: that original monuments, corners and lines must control. Thus, in very many instances, *wrong* is declared to be *right*, and right wrong. Not *what should the line be*, but "*where was the original line run.*"

The Code of Instructions lays down this rule, "In locating a deed upon land, the rule is, first, to find the original lines, as actually run; second, to run lines from acknowledged corners or calls; third, lines run according to the courses and distances called for in the deed."

Again, "There is no inflexible rule for running the open or lostl ines of a survey. Each case depends upon its own circumstances."

"The Act of Congress of 1805 makes the lines and corners of the Government surveys, as now established and recorded, the true line of the survey, and the quantity of land the true quantity, whether accurate or not."

"When there is a discrepancy in the calls, the line actually run is to be found by having recourse to the more certain, fixed and natural objects called for in the boundary."

Owing to the fact that the Government surveys in Ohio were not all made on the same general plan, or from similar methods, part of them being based upon the true meridian, while others were made from magnetic meridians, the surveyor's work in retracing old lines becomes both complicated and difficult, and too often quite unsatisfactory to himself, if not to his employer. It therefore seems quite indispensable that the land surveyor should familiarize himself with the details of, first, the original surveys made by the general Government; second, subsequent surveys made by direction of the Government—the divisions of original tracts—and lastly, to exhaust the testimony at his command in order to the more certainly know what his duties are, and what course he should take to properly reproduce old corners, retrace old lines, to do justice to the parties in interest. Having followed out the foregoing general directions, the surveyor will in most cases be able to "give a reason for the faith that is in him," and to satisfy those who employ him that his work is to be relied upon. This public functionary is a sort of *trinal* being. He is judge, jury and counsel; he is often called upon to discharge all of these duties.

It is all important that he knows just *what* to do. The next, to know just *how* to do it.

Having devoted as much space to the consideration of "*What to do*" as we care to, let us now consider the next step,—*How to do it*.

A surgeon who had performed a most extraordinary operation upon a patient who was supposed to be beyond relief, was asked by another surgeon of less skill and experience, how he did it, replied. "It cost *me* five thousand dollars, and four years time to find that out."

In our profession it is different. In the first place, there are but few surveyors who can afford to pay large sums of money (for a most excellent reason) for technical information and training. Second, the tendency too often among young surveyors has been to attempt to do work which was beyond their ability; and, rather than take counsel of those more advanced, and with larger experience, and, too often depending solely upon a smattering knowledge gained from some rudimentary work on surveying, have

plunged into the most difficult cases—have assumed to know all about the profession, even to its most intricate details,—have done their work in a manner quite indifferently, to say nothing of accuracy. From these survey deeds are made, complications arise, the surveyor's reputation is attacked, and, if not entirely ruined, is much injured.

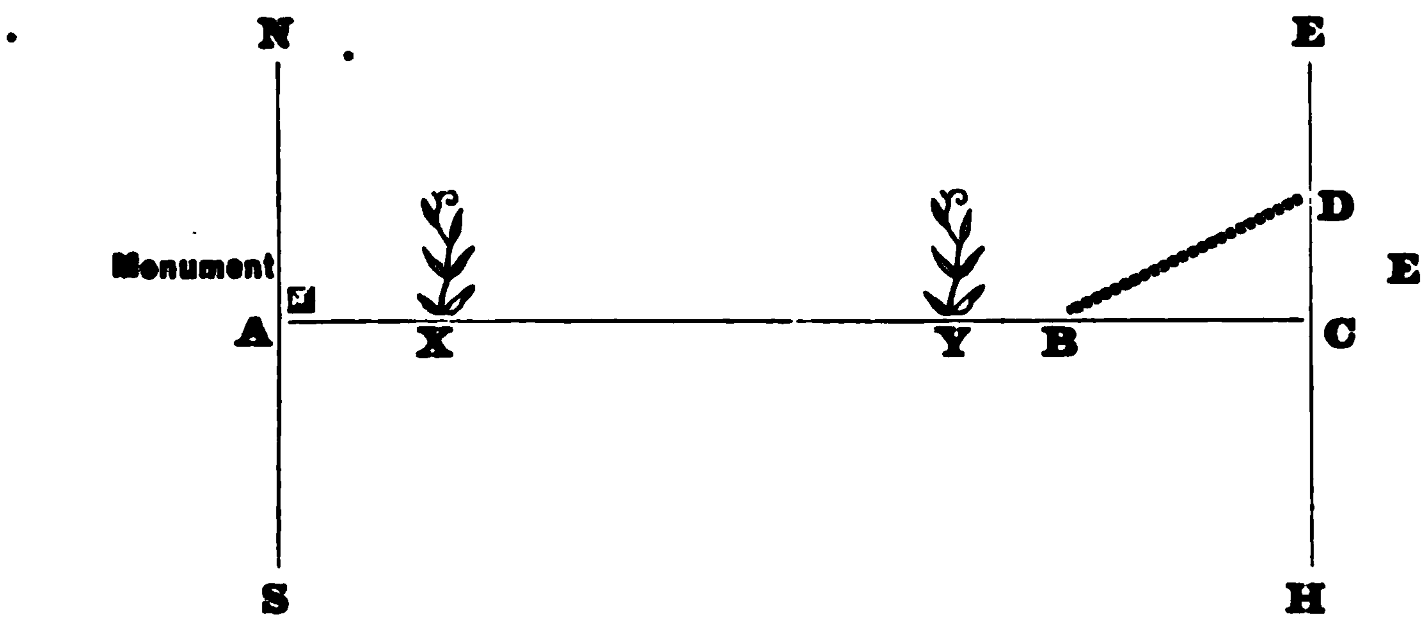
Some time since this Society discussed the advisability of establishing a standard of qualifications for the surveyor. Doubtless something of the kind would be of much value to the public; and in the end would be advantageous to the profession. There are, however, difficulties in the way that do not seem easily got rid of; which *may* in the near future be solved. For young surveyors for the present, we would recommend a careful perusal of the "Code of Rules for the Government of County Surveyors," prepared by Mr. B. F. Bowen, for the Secretary of State, 1882. And if possible, to secure a position with some one engaged in that branch of work, that he desires to fit himself for. But preparatory to all this, he should receive a thorough training at some well established university, or technical school, where he can have the advantage of professional instruction, both in the class room and in the field.

It is probably true that no other State in the Union has so many different kinds of original surveys as has Ohio. And it is also probably true that no other State *will* be complicated with so many kinds of surveys as Ohio. We do not care to enter into the history of these complicated surveys. Nor do we wish to take up space in relating the trying experience of some of our surveyors, who have as many as two or three different kinds of original surveys in a single county.

It will be enough to say that no surveyor can expect continuous plain-sailing, even in the old "Seven Ranges."

But few questions of interest have come before the committee within the year.

A question submitted by Mr. Arnet of Madison County, was presented and discussed. The following sketch may assist in understanding the points under consideration:



X and Y are two line trees ; and a monument at A, marks the west end of the line; but no corner can be found for the east terminus of the line. All that is found is an old fence built on the dotted line B–D, but the deed calls for a straight line from A east to the line E–H.

The question raised was, shall the line follow the old fence, *i. e.*, A–B–D, or shall the line be run through taking the monument A, the line trees X and Y and produce the line to C, and there place the corner?

With this understanding of the case, we would say that according to the rule laid down in the case of "Avery's Lessee *vs.* Baum's heirs, Wright 576," which reads: "* * But if without agreement the parties, in ignorance of their true line, which is afterwards discovered not to be the true line, such occupancy will not conclude them."

This decision would sustain the views of the committee, which were that the line should be run from the monument A, through the line trees X–Y, and produced to the intersection of the line at C, and there establish the corner.

Another question was raised as to determining the date of surveys by counting the number of annulations between the bark of the tree and the witness mark. It is the opinion of the committee that the annulations are a true index, when correctly interpreted. There is this caution that should be observed: some of our more growthy timbers will at times make what may be

called second growths, or possibly third growths in certain seasons, wherein we have intermittent periods of *wet* and *dry*.

A careful examination will, however, discover that there is a marked difference between these shades, or apparent annulations, and the clearly defined line which indicates the annual growth.

J. B. Strawn,
Chairman Committee on Land Surveying.

President Varney: I had a slight criticism to offer on Mr. Strawn's report. It is nothing very serious so that he need be alarmed. I would like to know if any of the members of this Society have made any observations or have any information as to the correctness of his statement, that you can determine the age of a tree by the rings. I see he makes the statement that in a certain case there were just twenty rings, and therefore the tree was just twenty years old. I would like to know if that way of determining the age of a tree is reliable.

Mr. Sager: I would say in regard to that, Mr. President, that I have tested that matter I suppose hundreds of times. I have had a great deal to do in the woods, and I have tested it a number and number of times in Michigan, and I have tested it very, very many times in my own County, where I have surveyed for about twenty-five years. This matter came up in the "New York Tribune," some years ago, in an article in which the author stated, that there was no reliance to be placed in that matter. That communication was answered and it drew out from the surveyors, I might say all over the country, expressions of opinion, showing that I was right. I may admit here that I was the one that answered the communication published in the Tribune, claiming that you could rely upon that test. There is a distinct growth for every year that a tree grows, and that I have had opportunity right at home of verifying over and over again, in the case of locusts and hard maple and sugar trees, as we call them, and ash and all woods that have a rather loose grain between the two hard concentric circles.

President Varney: There is no doubt in my mind, that there is a growth for each year, the question is whether there is not three or four of them.

Mr. Lee: Mr. President, a few years ago I had occasion to observe the annular growth of trees. I had occasion to do some work in a piece of woods which had been more or less damaged by a hail storm, and while engaged in that work I took particular notice of the fact, that in each instance the trees showed a separate ring for each year of growth. There was a distinctly defined ring upon each tree, for each year.

Mr Bone: I would say that I had occasion a few years ago with Brother Harvey, to run a line about twenty miles long, that I think had been run about seventy five years before, and in the course of that line we found some fifteen or twenty different trees which had been marked when the line was run before, and every one of the trees contained a ring for each year, from the time I think the former line was run seventy-four years before, and we found no tree but that agreed with that fact so far as we could count them. Some of the growths were mingled a little on different trees during dry years, and sometimes were so close together that it was almost impossible to count, but we found no tree, in running the line, but what agreed with the fact.

President Varney: I wish to say that during the first year I was County Surveyor, this question came up in an investigation, where notice was served under the statute, with which you are all familiar, and there was testimony as to the age of a certain tree. I need not now describe how that fact became important in the testimony, but will say that the age of that tree became a very material fact in the case. Some men claimed that the existence of the rings was no test at all of the age of the tree, and it devolved upon me to decide a certain point in the testimony. I decided that the test was absolutely reliable. Within a year after that, some of the parties interested came to me with satisfactory evidence, showing that in that particular case the test was not reliable, and convincing me that there were actually more plainly marked rings than the number of years since the tree had been planted.

Mr. Sager: Several years ago, I made a number of experiments on this subject, and made it quite a study, contemplating writing a paper in reference to the matter; but finally my attention was taken away from the investigation, and my paper was never

6

written. However, I made a few observations that, I think, settled the question you speak of, so far as I was concerned. I was puzzled in the same way. I do not believe that the annulations always show the age of the tree, yet the scar on the surface of the tree, when it is covered each year by these annulations, does record the number of years. If you count the number of annulations over the scar, it will be accurate, but if you go into the center of the tree and count the annulations, it does not indicate the age. For instance, you might cut into the tree toward the top, and it would indicate one age, and then close to the ground you will find a very great difference in the number of annulations. I recollect of having a lot upon which there was a cut of about three feet depth, and I know absolutely at that time there was no kind of shrubbery there whatever. In four years' time, there was a small hickory sprout sprang up, very thrifty, and grew as high as my head, and when I cut it off close to the ground, there were twelve annulations; whereas, I know positively, that four years ago there was no tree there at all. But I believe that the scar on the surface of the tree is only covered by an annulation each year. I am like Mr. Strawn; I have had hundreds of instances of that kind, where the annulations upon a scar on the surface of a tree have indicated the time, and I think it is very reliable evidence.

Mr. Harvey: I would like to make one suggestion. I have been a little cautious in counting the annulations on a tree of comparatively young growth. It is very difficult at times to detect just where the period of rest occurs in trees of young growth, and I think the difference of opinion in regard to the annulations upon trees, in the minds of surveyors, may arise because of the excessive growths of young timber, which may appear to show the number of annulations, when by careful examination you will find one. By carefully examining the texture of the wood, you may observe when the period of rest occurs, where it is an annulation, and when you have detected each period of rest, and have counted the separate annulations, you will find that the evidence is reliable.

Mr. Bowen: As I understand it, a tree is like a human being —there is a period of growth and a period of decay, and there are, in the history of trees, certain times when it will be extremely

difficult to ascertain when the period of rest occurs, and extreme care should be used in determining the distinct annulations.

President Varney: Possibly the instance I referred to is similar to those of Mr. Sager. I never investigated it beyond that, but when the evidence was produced to me that the annulations I found on the tree did not indicate its age, it shook me up pretty badly.

Mr. Sager: If there is a dry spell for a while, and then we have copious rains, it sometimes gives to the tree what is known among nurserymen as second growth, and may give to the tree the appearance of two or more distinct annulations, but if you call to your aid the assistance of the microscope or magnifying glass, in that way you can etect the different annulations. Between the annular rings, as I call them, you will find a kind of grain that is more open and more porous than you will find in the ring itself, and it may be due to this fact that in some instances the annular rings do not appear to indicate the age of the tree. You have all noticed, in the case of a pear tree, for instance, there is sometimes a second blossoming after the fruit has been well formed, and sometimes after the fruit has been picked, you will find a second blossoming, due to a kind of second growth. This will form, in the case of a tree, a shade of color a little different from the balance of the ring for that year; but there is a grain, or granulous part of wood that will distinctly mark the different annulations, and indicate the resting period.

A Member: Do you count the bark in counting the rings upon the tree?

Mr. Sager: No, you must not count the bark.

Secretary Brown: I would like to ask a question of Mr. Strawn, which occurred to me and that is, why was it, that in two tracts of land in Ohio, the townships are five miles square; that is, in the Western Reserve and in the United States Military Tract, and everywhere else in the United States they are six miles square?

Mr. Strawn: Mr. White, I believe lives in one of those districts and can probably answer your question.

Mr. White: I cannot answer your question; I do not know why it is.

President Varney: I think it is very simply answered. One was under the United States regulation, whereas the Western Reserve or the northeastern part of the State was run by the Connecticut Company, and they simply took a notion to run it in that way.

Secretary Brown: That will answer as to the Western Reserve, but how about the United States Military Tract?

President Varney: No one knows. That is a conundrum. I will give it up.

Mr. Sager: The United States regulations exempted in a certain manner, those tracts; that is, this ground was all exempted for military purposes, and some for educational purposes. That, however, in the case of the Seven Ranges was designated differently, but prior to that certain grounds were set apart for military and educational purposes, prior to the going into effect of the law of 1785, and those districts are run accordingly.

Secretary Brown: But the United States Military Tract was run after the Seven Ranges, and lies just north of us, and includes the northern part of Columbus.

Mr. Sager: I give it up then.

Secretary Brown: There is another question I would like to ask, and that is, between the Miamis, beginning with the Simms Purchase and then extending up between the Miamis, why is it that the Ranges run east and west and everywhere else they run north and south? Isn't that true Mr. Bone?

Mr. Bone: Yes, that is the case, but why it is I do not know. They commenced down at Cincinnati and made their base line there and ran north between the Miamis; but why it is I do not know.

Mr. Strawn: That is a conundrum for the Chairman of the next Committee on Land Surveying to answer. (Laughter.)

President Varney then urged the members of the Society to bring before that committee as many problems for solution as they could, so that at the coming meeting of the Society the committee would have more problems and propositions to report to the Society for discussion.

On motion the Society adjourned till to-morrow, January 10, 1889, at 8:30 A. M.

The Importance of Properly Marking Surveys.

BY HOMER C. WHITE.

That surveyor who makes a careful survey of a tract of land for the purpose of establishing boundary lines, using in the execution of the work, the best instruments, and yet, leaves no lasting monuments by which future surveyors may be guided to the corners thus established, has failed to perform the most important part of his task—leaves his work unfinished—badly done.

That surveyor, whose field work is indifferently done, whose instruments may not be up to the highest standard for precision and reliability; but who, when he has his corners established, sets there, permanent, stable, conspicuous monuments, has done his work well. Had surveyor No. 1 completed his work as did surveyor No. 2 we should call his work *excellently performed.*

Of what consequence is it that measurements were made with an improved steel tape and in the most approved way, that bearings were taken with a finely adjusted needle and that observations of angles were made with a perfect vernier if the next surveyor who is called upon years later to retrace those lines, and possibly by means of inferior methods and instruments, be not able to find the original corners?

True, surveyor No. 1 may calculate to a certainty the exact number of acres enclosed by the lines which he has so carefully traced, but by reason of his omitting to set proper monuments, the owner of the tract may be forced to part with more acres than enough to balance the extra expense incurred in setting proper monuments.

Two adjoining land owners dispute over a boundary line. A conspicuously marked stone fixes beyond question one end of the line. At the other end, about a rod apart have been found evidences of two stakes presumed to have been set by different surveyors at different times, which is the earlier cannot now be determined. At any rate, each party feels certain that the land in

question belongs to him, and confident that the law is in his favor, the case is taken to court for trial. The first trial is followed by the second, and that by the third. The amount of land involved, insignificant in the beginning has long since been swallowed up in attorneys' fees. Now the question is *not* who owns the land? but, who pays the costs? From the lower courts the case is taken to the higher, until the court of final appeal is reached. The decision of this court is rendered and the lucky man, elated over his success, becomes a raving maniac. These are the facts as they occurred in a case over a disputed line in Trumbull County, and this is only one out of hundreds of similar cases which are occurring constantly all over the land and simply from lack of proper monumenting on the original surveys.

Another case, but why multiply illustrations? You will all agree with me that the setting of monuments is a very important part of the surveyor's work, a part which, though often carelessly done, if not omitted entirely, requires care and thoroughness to be successful. The surveyor, who determines in his mind to do this part of his work thoroughly, may expect to meet with opposition from the very parties who are the most deeply interested—the land owners themselves.

"That will be too much trouble."
"It will be too expensive."
"A wooden stake is good enough."
"I'll know where the corner is as long as I live."

And a hundred other objections will be made when the surveyor suggests setting proper monuments. But the most delusive and untrustworthy of them all is a promise made by the land owners, to themselves set monuments at some early day, convenient to them, which never comes. Besides the objection to relying on a promise of this kind, is a greater objection, and that is, if the work is done at all, it is liable to fall into the hands of careless workmen, who, not understanding the requirements of the case, are apt to frustrate the end designed in setting the monument. The surveyor is the proper person to set the monument.

And now arises the question, What constitutes a proper monument? F. Hodgman answers this question very satisfactorily in

his paper on "*Monuments*," published in the Ninth Annual Report of this Society.

We can readily understand that a proper monument should be composed of indestructible material; that it should be so shaped and marked that its identity could not be mistaken; that it should not obstruct public travel, that it should be immovable, and so placed that it may be readily found. Thus may be described a theoretically perfect monument; but, with monuments as with other works of man, perfection is just beyond. The closer we approach the above standard, the nearer we arrive at perfection, and this should be our aim, always taking into consideration our environments—the accuracy required, the interests at stake, and the possibilities of the vicinity. If you are surveying farm land, valued at $1 25 per acre, and have the material at hand whereby you can erect a monument which would do credit to a city lot, by all means, put up the monument; it may some day come within the city limits. If you are surveying city property, and cannot persuade your employer to furnish the best material to be obtained, at least insist that good, substantial monuments be set, and *hold the fort until you have carried your point.* There are some points on which surveyors ought to be firm, and I believe the setting of monuments to be one of them, in a double sense.

Perhaps the writer has set as many poor monuments (made from half decayed fence rails) as any other member of the Society, but in retracing some of his early work, he saw the folly of such a course, and his later practice has been, where the material could be conveniently obtained, to set hard sand stone or flag-stone monuments, top squared and dressed with a chisel, and the center of the top face marked with a cross, or shallow hole drilled into the stone. The stones are made two and one half to three feet long; top end six inches square; bottom, nine to twelve inches square. Top and bottom sides are made parallel, and stone is set in position and plumbed, and a firm bearing secured on the under side before the earth is replaced about the stone. Where it will not interfere with travel, about four inches of the top of the stone is left projecting above the ground.

Just here a difficulty is suggested which may be hard to overcome. How shall we mark corners over which traffic is con-

stantly passing? Evidently the monument cannot be left projecting above the ground; neither should it be covered up, without supplying some means of readily finding it without digging over an eighth of an acre of ground, more or less, with a pick and shovel. We have thought that this difficulty might be overcome by means of State legislation. This is our plan:

Let a law be passed requiring *every* survey, after being properly marked, to be put upon record in a place provided for that purpose by law, and where the public can have free access to the records; and let no survey or plat of a survey, not properly marked and recorded, be considered as evidence of a survey, or have precedence over a plat of a subsequent survey properly marked and recorded.

To some, this course may appear extreme and unconstitutional. I cannot see that it is so. The State, which proposes to sustain an individual in his right to land, the title to which he has come in possession of in the regular way, certainly has the right to say how the boundaries of that land shall be established and perpetuated. Deeds are required to be recorded; why not surveys? How often we have felt the need of *enforced* legislation of this kind when, after searching diligently the records of deeds for information, and finding nothing more definite than that the land in question is bounded on the north by lands owned by Jones, on the east by lands owned by Williams, and so on, and contains so many acres and hundredths of an acre, according to the survey of so and so, made on such and such a date; then, going into the field and finding evidences that a careful survey had been made, and reference trees marked near corners, but no lasting monuments set. If we were tempted to say nothing improper, we could at least with propriety exclaim, as did a certain wise man of old, "vanity of vanities; all is vanity!"

Such legislation, properly enforced, would overcome, in a great measure, many of the difficulties arising from incompetent surveying under the existing state of things. As there will be whisky drank as long as there is whisky to drink, so there will be surveyors as long as there is land to survey; and there will be surveyors, good, bad and indifferent. The State recognizes the right of individuals to fix their own boundary lines, and if the parties see fit to call in a third person, be he ignoramus or collegian,

to fix the line for them, they have the right to do so, and the State will sustain them in the action. Hence, the surveyor may be ignorant of the first principles of algebra, yet if his work be properly marked and recorded, so that *other* surveyors may be able to trace it, it is far superior to the more careful work of his educated brother who does *not* fulfill these latter requirements.

We cannot annihilate the poor surveyor; he is with us; he is a part of us; he is very closely akin to some of us; he is our brother, what we want is *not* to "squelch" him, but to throw those kindly influences and safe-guards around him, by means of which, in the fullness of time, he may emerge from the darkness of ignorance which surrounds him, into the bright sunlight of knowledge.

Again, could our most careful surveyors of the present day appear on earth one hundred years from now, O, how the curses and maledictions heaped upon their heads by the scientific surveyors of that age will cause their ghostly shades to shrink with affright into the friendly darkness of oblivion!

So, my kind brethren of the Legislative Committee, in your exertions for his welfare, I beg you, deal gently with the poor surveyor. Keep in remembrance the days when you did not know as much as you do now. So much for the poor surveyor.

When stone monuments could not be readily obtained, the writer has frequently used two inch iron bars, three to four feet long, which have the advantage over stone of being more readily set, and the disadvantage of being more easily moved, and where corners are for any reason hidden or obscured, references are taken to them from well marked surrounding objects, and these references inserted in the description in the deed, which we invariably insist upon writing, when the description for the deed is to be made from our survey.

We would be pleased to hear from the members of the Society, give us your "experience" in monumenting. We have purposely made our paper short, that more time might be devoted to the discussion, wherein the Society may reap the benefits to be derived from an exchange of ideas on a subject of great interest to surveyors, and of vital importance to the welfare and peace of the community at large.

The Chair: The request has been made by some one that we ought to have some more discussion of Mr. White's paper on the "Importance of Properly Marking Surveys." If you will allow me to say it, there were some positions taken in that paper which I felt like criticizing, and I am very decided in my objections. He recommends that a law should be passed requiring that monuments should be set in all surveys. I am very much averse to having our Legislature try to furnish brains for people, and enforcing things which people should do themselves. It would be a law very difficult to enforce. When you attempt to touch the rights of men to bargain and sell, and their methods of bargaining and selling, you are on very delicate ground. There are some old rights coming up from common law which it is very dangerous to attempt to touch. I think all that would be necessary for a man to see that that would not do, would be for him to attempt to write such a law; I have just passed through that myself. Ten years ago, I made maps for Cuyahoga County, and I was very much annoyed at the imperfections of the deeds, and I think we ought to have some legislation to right it, and I advocated just exactly what Mr. White advocated in that paper, and I got out of it by having a member of the Legislature tell me that if I drew up such a law, he would introduce it, and try to carry it through; and I spent several pounds of fish, for you know it takes fish to furnish brain labor, and I don't know how many quires of legal cap paper in trying to frame a law on the subject, and the further I got the more firmly I became convinced that that was not the direction in which we should work. I am convinced that the making of laws is a serious business, and that we should confine ourselves simply to protecting what we have. I feel if we could get some means of protecting the monuments we do set, it is all we should attempt at present; and then, do just what Mr. White did in that paper—exhort engineers and surveyors to set monuments.

Mr. Haseltine: I wish to say a word in reference to corners. Mr. White says when he plants a corner, he endeavors to witness it. That is a practice I favor, and which I practice more and more each succeeding year. Monuments are liable to be displaced, and are hard to find when there is snow on the ground, but if you

have a tree near, or a corner of a house, it is a great help. I do not favor iron pins in farm surveying. I generally place some foreign material around a monument, as broken glass, or chunks of bricks, so that if the stone is removed, or the marks become defaced on it, by digging down and finding the broken glass or crockery, or pieces of bricks, it settles the question more effectually in the farmers' minds that that is the corner.

Mr. Sitz: I have done that myself in so far as placing glass and broken crockery are concerned. My predecessor started another good thing, I think, in the way of setting monuments. I invariably drive a stake into the ground beneath the stone about three feet long; that will remain there perhaps for one hundred and fifty years.

Mr. Haseltine: I don't see how you can drive a stake two or three feet long in the bottom of the hole; our soil is clay and it is as much as we can do to get a stone down without putting down a stake.

Mr. Sitz: We have a very deep soil in our country, and we don't have that trouble.

The Chair: I don't know that it is proper for the Chair to take too much part in the discussion, but I wish to say that I have adopted this method of driving a stake below the bottom of the stone in some cases. Before driving the stake, I saw it around at the top at the distance to which you wish to drive it, then drive it down until the cut is even with the surface of the bottom of the hole and then break it off. I have found old stakes or the position of old stakes a number of times where there was scarcely any of the stake left, just little remnants, but the place that the stake occupied was a different colored earth, it was black, the remains of rotten wood, so that there is no mistaking the position of the stake; that is a very effectual method I should say of marking. I remember in one case of laying out a new road, and there was one of the angles of the road right on the brow of the hill, where we knew it would be cut down some five or six feet, probably and it was a question what to do with the monument; a suggestion was made by one of the men assisting me which I acted upon; they had a drilling machine with which they had been drilling for some purpose, and we put a hole down about three inches in

diameter and about nine feet deep, and we went to a kiln where they had been burning charcoal and procured charcoal dust and filled the hole up; it seemed to me that we had struck a very good thing, but every man has his own peculiar conditions and circumstances to deal with, and the only thing that I wish to impress is, the importance of fixing it in some way. Now, I have no fault to find with referencing monuments; it is a good thing if not carried too far, but I never allow reference of a monument to go into a deed; I think it is out of place there; we should all try to do our work well but we should also understand our limitations, we should understand that the best of us never do our work perfectly; there was never such a thing as a line that was measured with absolute accuracy, and you are liable to have a conflict of authority, and that is what we do not want in deeds; my practice is to put down a good stone monument or some other thing as good, so I make but very few references; I put monuments in that will stay there and that I can find. Of course, in streets, where monuments are all covered up we must do something; it is often advisable to reference to a telegraph pole or a water hydrant or a mark on the curbing, or something of that kind, that I simply preserve in my own notes for the purpose of finding the monument, and for the help of other surveyors; we freely give these notes to our associates whether we are friendly to them or not in other things; but, what I wish to impress upon you is, to have your monuments of such a character that they will stay there, and be careful not to have any divided authority; for instance, it is fifteen years since I have ever allowed, in making a survey through woods, any man working for me to mark a tree; while I try to do my work correctly there is the peril that I may be off from the line, and if they mark a tree that becomes a monument.

Mr. Scott: I agree with the President in that remark in regard to marking line trees. Any surveyor who has had any experience in surveying military lines can not help but agree with him there. The law I presume will hold us to the marked trees, and there is not a straight line, I don't think, in those surveys.

Mr. Haseltine: When I consider how sadly we would be at sea, if our early surveyors had not marked trees, I must say I differ from you about marking lines. My object in running a line is

to mark it so that the next man can find Haseltine's survey. It seems to me that a man who is competent to run a mile or a mile and a half line is certainly able to make a reference of twelve or fifteen feet to a tree, it certainly seems to me while we may not run an ideal straight line, that it is better to run a line that some person who comes afterwards can find the line. Is it not better to have a line of that kind that can be located on the line than to have an ideal straight line in the deed?

The Chair: You remember my reference to the importance of having the corners preserved?

Mr. Haseltine: I was going to speak of that, but you can not always have monuments that are sure to remain and be immovable.

Mr. Davisson: In regard to marking witnesses to corners and putting it in deeds, I differ from you, where surveys have been made and no record of those surveys have been made and the only record is in the deed, especially in running lines where corners come in streams, and the distances are given between certain points, but at the same time those points are in the streams and if you do not mark those points in some way upon the bank, it is going to give you a great deal of trouble to retrace those old lines.

Mr. White: Quoting the language of Mr. Hodgman in his paper on monuments, he says that it is more important that individuals know where their lines are and that they are unchanged without their consent than it is that they have the exact number of acres.

The Chair: There are repeated decisions in courts covering that point and I have never seen one to the contrary.

Mr. Strawn: I promised to say a word in regard to the matter of monuments in surveys in connection with Mr. White's paper. The matter was talked over at the hotel by some of us in regard to how we should witness a monument where there were no objects of a permanent character in the vicinity to witness to. This I venture has been a serious problem in the mind of many a young surveyor, and probably some older ones. I was informed by quite an intelligent old German gentleman, who had done some surveying in Germany, of the methods used in some parts of Ger-

many, and I think it is a matter of law in Germany that where a corner stone is set, that the corner stone shall be first dressed; after the stone is dressed it is split in two, making two corner stones, substantially; then a cross is put on the side where the split is, but without any dressing whatever, simply a cross made; then one stone is planted in the highway or wherever it is desired to place it, where it will probably not interfere with traffic or something of that kind, to a depth satisfactory to the surveyor or engineer, and the other stone is set as a witness stone, with the split side facing toward the true monument, and is planted so that the top of the stone is above ground, or where it is easily found; the witness stone is placed where it is not likely to be interfered with; in case of a dispute as to the witness being the true index to the corner, their custom is to set stakes and get the true position of the corner stone and the witness stone, and then take up the two and clean them off, and if they will fit together, that has been regarded as conclusive evidence of the identity of the two pieces of stone. I think that we could adopt this German method in many cases to advantage, especially where the timber is of uncertain character or liable to be removed, and where we have no permanent buildings or other objects; especially where we have made a very careful survey, I think something of that character would be a good thing, and while I have only in a few instances practiced this, I feel that I can look back with some satisfaction to what little I have done in that line.

Mr. Weber: It has been my practice where I have made witnesses to set them about four rods or one chain length from the corner in the line and then made a note of that; if you set it far enough away they will not mistake it for the corner.

Mr. Strawn: I think I would prefer an offset for the witness if it could be done.

The Chair: I am inclined to favor the line; then you have it right in the line run.

Mr. White: The President objects to witnesses being inserted in deeds for the reason that we may make a mistake in measurement; now, if they should be kept out for that reason why should we not omit the length of lines for a similar reason for a description.

Report of the Committee on Civil Engineering.

Your Committee on Civil Engineering respectfully submit the following report, which is not intended in any sense to be exhaustive, but consists merely of notes upon such of the work as has come under our notice, that we think may be of interest to you:

For convenience the work of the Committee has been divided, to correspond with the different departments of the subject, and we have this year to report to you upon Water Supply, Bridge, and Municipal Engineering.

C. A. JUDSON,
Chairman Committee on Civil Engineering.

Water Supply.

BY C. A. JUDSON, SANDUSKY, O.

In the department of water supply there has been considerable activity, not only in the construction of new works, but especially in the enlargement and improvement of works that have been in operation for some time, but which have been found inadequate to meet the demands of natural growth in population and manufacturing, or have become unsatisfactory in respect to the quality of the water supplied. We note the following as the principal improvements throughout the State that have come to our notice during the year:

Works have been completed or were in progress during the year at the following places:

Ashtabula, Martin's Ferry, Franklin, Findlay, Marion, Washington C. H., Wellston, Milan, Delaware, Defiance, Latonia and Cambridge.

Works are proposed or are about to be commenced at the following places:

Bowling Green, Westerville, Uhrichsville, Conneaut, Fostoria, Urbana, Circleville, Louisville, Swanton and Mechanicsburg.

Cleveland is building a new lake tunnel under some difficulties, while the extension of the water mains has progressed so far as to bring the total distribution up to 300 miles. The water at times is not very good, and a new outlet for sewage is talked of.

The supply of Cincinnati has been condemned by a board of experts, who recommended improvements that will cost approximately $6,000,000.

Zanesville is to add a stand pipe at a cost of $40,000.

At Newark there is talk of a stand pipe, new pumping station, machinery, etc.

Sidney is to add a new pumping station, new engines, mechanical filter, stand pipe, and a mile of mains.

Norwalk has been expending $30,000 in improving the works by the purchase of more land and sinking new wells.

Cleveland, Cincinnati, Akron, Sandusky, and others have added new pumping machinery.

At Canton they are looking for a larger and purer supply.

Columbus wants a larger supply and proposes to expend a large sum in extending mains.

At Ashtabula the arrangement for supply is somewhat novel. The water is taken from a silt well eight feet in diameter and ten feet deep, located on the lake beach, one hundred feet from the shore line; from this well some four thousand feet of six inch tile radiate, planted in the sand from four to six feet below the level of the water in the lake. Information is not at hand as to the character of the tile used, nor the method of laying and joining them. It is doubtful if the plan will prove permanently satisfactory either as to quantity or quality of the water obtained.

The question, "How to secure a pure supply" is agitating many water boards throughout the State, and should agitate more. Some are resorting to wells; others dependent on surface water, are building new storage basins; others still are purifying the old supply by filtration. The tendency at present seems to be toward mechanical filtration of the whole supply. The filter itself has been so improved recently, particularly in the method of cleansing, as to enable it to do effective work at a reasonable expense. There is, however, this objection to the plan of filtering the whole supply: that is, that a large portion of the water filtered is used

for purposes that a less pure water would answer as well, *i. e.*, for flushing sewers, for fires, for water closets, for boilers and elevators, for sprinkling, etc. The expense of filtering water used for these purposes is practically money thrown away. Is not a system of house filtration, where only the water used for domestic purposes is filtered, the wiser one after all? It is at least clear that this is a question we ought to consider carefully before rushing into the business of wholesale filtration.

In the matter of pumping machinery, decided improvements have recently been made, looking to greater economy in fuel, and more efficient service. While a few years ago a duty of more than sixty-five millions was rarely obtained, even in duty trials, now many pumping engines can show an every day duty exceeding one hundred millions, which means a saving in fuel of more than thirty per cent. The contracts placed during the past season indicate that the tendency among water works people is toward higher duty, and consequently greater efficiency of pumping machinery.

The use of lead pipe for service is growing, though many are using galvanized iron. The objection to galvanized iron has been found to be, that while the coating may protect the main part of the pipe for some time, yet in joining the lengths it is sure to be rubbed off in places, and at those spots, the pipe of course, will be eaten through as quickly as common wrought iron.

For mains, cast iron is in general use, the tendency being to lighter weight and better make and material.

Mr. Judson here read his report.

Mr. Strawn: I would like to ask Mr. Judson if there has been any effort to grade the pipe in building water works, as to the weight and quality of cast iron pipe, for instance, where you are using any small cisterns, and where the pressure would be much less than where these larger cisterns are used, whether there has been a tendency there to use a lighter quality of cast iron pipe.

Mr. Judson: I would say that there has. I know at Oberlin, Ohio, whose works were built last year, and I think Mr. Dunham planned them, that he used a lighter weight pipe for the simple reason that he didn't intend to carry a very heavy pressure. Where they have simply a gravity system and no unusual pressure they use a lighter weight pipe. I think we often use more iron than is

needed. I have found in our experience at Sandusky that pipes are not cast uniformly, that is, a pipe that should be 5/8 of an inch in thickness all around is 3/8 on one side and 7/8 on the other. I think more attention should be given to this matter and better material should be used; I think we could use a lighter weight pipe if that were the case.

Mr. Strawn: I would say in regard to Oberlin, that I think one of the reasons that they used a lighter pipe was the lightness of the appropriation. There was only $50,000 to construct the water works and they tried to get the most out of the plant possible with the amount of money. I fully agree with Mr. Judson in regard to the uniformity of the pipe, it is just like a chain, it is no stronger than its weakest link; in calipering many miles of pipe I found that the thickness of the pipe on one side was not more than half as thick as on the other. I think if engineers will insist on a high grade of pipe and uniform in thickness, that there will be in the near future a great saving in material, and cheapening of the construction of water works thereby.

Mr. Alter: I would like to ask a question, has any one in the State had any experience in using wind as a motive power in a water works to do the pumping, and whether any one has had any experience in regard to using washers at the joints of the pipe to reduce the friction of the flow through the pipes?

Mr. Judson: I do not know of any case where a wind-mill is used for the purpose of supplying a town with water. I know the people of Milan, a place up near us, have been putting in water works recently; it is a small place, perhaps a thousand inhabitants. Their plan at first was to use wind but they changed it and put in a steam-pumping engine; that is the only town that has come to my notice that thought of using a windmill for pumping water. Now, I didn't catch that last question.

Mr. Alter: I understand that there is a system of pipe being introduced, in which there is a washer put into the joints somewhat smaller than the pipe, and they claim it reduces the friction of the flow through the pipe.

Mr. Judson: I think all the effect it would have would be to reduce the flow of water. The only case of which I know of

washers being inserted in a pipe, is that some water works put in a disk with a smaller hole just over the fixers in order to cut the supply of water down.

Mr. Strawn: Isn't it customary to use a smaller opening into the main, where the service pipe that runs into the building connects with the main.

Mr. Judson: I think that is preferable; for instance, you have an inch pipe running into a building, I should say connect that to the main with a five inch ferrule as we call it, and it will give you an ample supply. You will get a great deal more satisfaction I think, to put in an inch pipe and use the smaller sized opening with the main. In some cities where they use connections for running elevators they will lay, for instance, a four inch pipe from the building out until within a foot or a foot and a half from the main, and then connect that with the main with inch or an inch and a half pipe, perhaps a foot and a half long, and they claim they get an abundant supply of water in that way.

Mr. Culley: I wonder if Mr. Judson can give us any information in regard to the filtration plan used in the East—at Long Branch; they have plants there that they claim will filter 3,000,000 gallons daily.

Mr. Judson: These filters have been put in at several places in the East; there is one at Bucyrus, and I would like to have Mr. Weber tell us about that.

Mr. Weber: We put in a filter about two years ago and it has worked very satisfactorily; before that we had a well from which we got our water supply, and we had a splendid water, but we had to have a greater supply and when we tapped the river there was a general kick; the people didn't want to use the water from the river because they were paying for the use of good water and they were compelled to do something, and so they put in these filters.

A Member: How much water do you use?

Mr. Weber: I don't know the amount.

Mr. Judson: What is your population?

Mr. Weber: About 7000, I should judge, and close to a thousand connections; pretty nearly every person uses the water. We have had better satisfaction than from the wells.

Mr. Brown: How are these filters made?

Mr. Weber: They are made out of sheet iron; I forget where they are made, but somewhere in New York.

Mr. Judson: The Hyde people make them; they are located at Newark, N. J., I think.

Mr. Weber: I couldn't give a very good description of them but they seem to filter the water as fast as needed.

Mr. Judson: These filters are simply made of boiler iron filled with sand. It is so arranged that the water, after passing through the sand, passes through little holes through which the water can pass, but the sand cannot; they are little copper disks that keep the sand from going through. After the filter has been used for a length of time, by simply changing the arrangement of the valves they change the current and so wash it out. They put in a quantity of alum for a co-agulante.

Mr. Weber: I noticed after we commenced to use the filters that where the lawns were sprinkled it had a bad effect on the grass; where they used a good deal of water it seemed to affect the grass.

Mr. Strawn: I think there is another reason besides the alum. Persons not accustomed to the use of hose upon their lawns are almost sure to overdo the matter. To sprinkle a lawn in the middle of the day, when the sun is hot and the grass dry, turning on the water from the hydrant, is too sudden a change. I have known lawns to be very badly injured and people sometimes thought there was something the matter with the water. There was an elaborate description of these hydrant filters in the Engineers' News within the past six months. They have been giving good satisfaction. Where they have a large quantity of water to filter they simply increase the number of these filters.

Mr. Judson: There are a number of these filters made, but they are all made practically on the same plan.

Mr. Davis: Going back to what Mr. Strawn spoke of in the first place, I don't think his proposition there is very advisable. I am always willing, where there is an appropriation, to do whatever you do, do right, and there you quit. If there is not a sufficient supply to supply the people they will be sure to grant the appropriation; if it is a good thing they will always appropriate the

necessary amount of money and think a great deal more of you when it is done than if you have the material too light and damage the work.

Mr. Strawn: Now, the requirements at Oberlin are not the same as would be needed at many other cities. Now, if you have a pipe that will stand a hydrostatic pressure under the hammer of 300 pounds to the square inch; if you were going to use it where you wouldn't need over seventy-five or eighty, it would seem unnecessary where you were going to make your pipe to perform the duty required in other places. Engineers are now coming down much closer on their specifications in regard to pipe, quality, thickness, etc.; but one of the greatest difficulties, as Mr. Judson has stated, is in the pipe not being uniform in thickness.

The Chair: I have just learned that Mr. Alter is from Indiana, and word has come to me also that there have been some experiments through Indiana and Illinois with wind power for water works. We would like to hear from Mr. Alter on this subject.

Mr. Alter: Mr. President, there are quite a number of places through Wisconsin, Illinois and Nebraska in which villages are supplied by wind power. We made specifications for a wind power water works at the little town of Kenton, in Newton county, Indiana, but about the time we were getting to work on it the matter got in Court. As I have had no further experience than that, I cannot say, but from those that I have talked with in many other places they are supplying villages and small towns with wind power, and it has proved very cheap and has done the work well, especially where they can use a reservoir. Of course it would not be practical where it had to be pumped into the mains, but for reservoirs it is undoubtedly the cheapest method in the West where we have wind the greater portion of the time.

Bridge Engineering During 1888.

BY H. J. LEWIS, COLUMBUS, O.

In the department of Bridge Engineering so much has been done and of such a varied character that a complete review of work done would almost fill volumes. This work is widely scattered, and no systematic statistics are at hand to give an idea of its nature or extent; so we must be content with a brief mention of some of the more noted instances.

In our own State, probably the most noteworthy work of the past year is the Huntington Bridge over the Ohio at Cincinnati. The channel span of this is the longest truss span in the world, being 550 feet center to center of end pins or twenty-five feet longer than its famous neighbor, the Cincinnati Southern Bridge. The falsework for this span, together with some of the iron, was carried away by high water at ten o'clock A. M., August 26th, 1888. Notwithstanding this it is now very nearly ready for the track.

The city of Cleveland has added another to her already splendid list of bridges in the new Central Viaduct completed December 11th, 1888. The Cuyahoga Valley section has a total length of 2839 feet; this includes a draw span of $236\frac{1}{2}$ feet over the Cuyahoga River, which is the most important part of it. The Walworth Run section has a total length of 1092 feet, and its longest span is 120 feet. The roadway is forty feet wide, and in addition two sidewalks eight feet wide. It is to be lighted by electricity and will have an electric railway.

Also, during the past year, the Maumee has been bridged near Toledo, the Muskingum at McConnelsville, part of the Pan Handle Bridge at Steubenville has been renewed, and the Miami River at Poasttown; this last being a 350 foot span.

A great deal of other work has been done varying in cost from a few hundred dollars to many thousands.

The Poughkeepsie Bridge, which was completed in the year just past, spans the waterway of the Hudson River in two fixed spans of 500 feet clear and three cantilever spans, two of which

are 523 feet clear and one of 521 feet clear, resting on six towers twenty-five feet long in the direction of the bridge. There is in addition the shore ends of the end cantilevers and trestle work, making a total length of 6767 feet, or more than three-fourths the length of the Forth Bridge. The foundations for this work were begun about October 8th, 1886, and the first train passed over it on the 29th of December, 1888. While this bridge is a great achievement from a professional standpoint, its commercial bearing on the railroad traffic between New England and the West cannot at present be estimated. One thing seems fairly clear, however—that it bids fair to serve as an entering wedge for a scheme to bridge the Hudson at New York City. This is simple self-protection to keep trunk line traffic from going around the city, and already a company has been formed which is willing to consider Mr. Lindenthal's scheme in which the preliminary estimate is placed at $15,000,000.

In passing, we may mention that the principal thing worthy of note in Mr. Lindenthal's design, aside from the very large size of the members, is the introduction of a stiffening web between the main cables of wire in addition to the horizontal stiffening truss used by Roebling. The span proposed for this structure is 2850 feet for the middle and 1500 feet each for the ends.

The same engineer is also interested in a scheme to bridge the Detroit River, near Detroit, with a main span of about 3000 feet.

It is also proposed to cross the Hudson just above Peekskill, with a suspension bridge of the old type, the span to be about 1700 feet, the stiffening trusses to be thirty feet high and forty feet apart, and about 370 feet longer than the span itself.

The new Manhattan bridge over the Harlem River at New York, is a fine specimen of the stiffened arch built in the form of a plate girder. The arches are 500 foot span, thirteen feet deep and six abreast.

A novel suspension bridge has been built carrying a six inch oil pipe across the Lehigh river at Mauch Chunk, Pennsylvania. The span of the cable between supports is 470 feet horizontally, and one support is 115 feet higher than the other.

A considerable amount of elevated railway structure has been built during the past year, among which is the Inter State Rapid

Transit Railway, of Kansas City. This is the first extended venture of the kind to be built in the west.

The Forth bridge, with its two immense cantilever spans of 1710 feet each, is steadily moving forward toward completion, but we will probably meet again several times before we can have the pleasure to record its successful conclusion. This work is so heavy that it has been necessary to erect shops and build it on the ground, and to this cause, and possibly to the fact that it has riveted connections throughout, is due the length of time taken in its completion. For in this country the pin connected cantilever has shown itself to be a form which could be contracted and built before it had got out of date, as in the case of the Brooklyn bridge, which, when completed, had to meet a traffic which was not in existence when it was designed. That is to say the elevated roads coming into actual existence during its construction had educated the public to a desire for rapid transit to an extent not dreamed of in its original conception.

Not exactly in the line of bridge building, and still very nearly allied to it is the Eiffel Tower which is now nearly completed for the Paris Exposition of 1889. This splendid structure, if successfully completed will rise to a total height of 300 metres, or about 984 feet, being 410 feet higher than our own Washington Monument, heretofore the highest human construction.

This tower is of open iron frame work, and in this manner removes the necessity for such proportional provisions in the way of foundation as was necessary for the monument. The framework also offers less resistance to the wind and at the same time admits of a widening of the base which would hardly be possible in a stone structure.

There is, however, a crumb of comfort in the fact that if the French have "seen us and gone us several better" in the matter of height, yet they were obliged to come to us for the elevators for the slanting lift in the lower half of the town; the American firm of Otis Bros. & Co., having secured the contract for this part of the work.

The Paderus Viaduct, over the river Adda in Italy, crosses a gorge about one thousand feet wide and two hundred and seventy-five feet deep in rather a novel manner. It consists of a stiffened

arch of four hundred and ninety-two feet span and one hundred and twenty-three feet center rise, supporting continuous lattice girders of about one hundred and ten feet span.

This is a distinctly European form, but while considerably more expensive than our own Kinzua Viaduct over a similar obstacle has this advantage, in that it affords a wide, high and uninterrupted waterway for a stream liable to sudden freshets. In the American Cyclopedia Annual for 1883, is a brief mention of a similar structure built in France, but of shorter span.

The arguments about the respective merits of riveted and pin connected work still go on.

There is no doubt as to the merit of a well designed riveted connection truss, where its size is such that it may all be properly assembled and fitted at the shop, and where the field riveting is reduced to a connection of minor parts, or done by machine as in the shop. The field riveting on the Forth bridge in Scotland, and on the Harlem river bridge in this country, is done by machines and is probably very nearly as good as if done in the shop.

Again it is not to be questioned that for long spans and heavy work, the pin connection has many points in its favor. The accuracy with which the different parts may be constructed, even in shops which are many miles apart, and never assembled until in erection is a strong point in its favor, and one which it is well nigh impossible to obtain in a riveted connection.

The awarding of the contract for the Hawkesbury bridge in New South Wales, Australia, some three years ago, to an American firm, and by a commission of English engineers, who were bound by all the conservatism of their race and engineering practice to the riveted girder, was a decided victory for the pin connection in heavy long span work,

This bridge consists of seven spans of four hundred feet each, resting on boiler iron caissons filled with concrete. The plan was submitted in competition with some fifteen others, representing bidders from England, Belgium, Germany, France, Australia and this country. It was not the cheapest plan, but the contract was awarded as expressly stated in the report of the commission for superior merit in design. This work was completed during the year past.

Considerable discussion was drawn out during the past yea on the subject of strains in bridge pins. The outcome point clearly to the conclusion that the present method of determinin bending moments, based on the supposition that the strain i concentrated at the center of bearing, gives results which ar amply safe for the pin, and at the same time tends to give eacl member bearing on the pin its due proportion.

Steel seems gradually advancing in quality as a structura material. By an improved process which seems to be a modificatio of the open hearth method, a steel is produced which shows ver satisfactory properties. Holes can be punched very near or ove lapping each other with almost no sign of flow in the metal. I the same metal knots are tied and bends are closed down col without a sign of fracture. Indeed it is said that one end of bar can be bent double cold, and the other end tempered to cutting edge. In actual tests of full sized eyebars the elastic limi was from 30695 to 35050 and the ultimate strength from 54229 t 58608, showing a decided uniformity in the different bars consid ering that carbon varied from fifteen per cent. to nineteen pe cent. and phosphorus from twenty-two thousandths per cent to fifty-one thousandths per cent. This steel is produced direc from the ore in about three heats, and is quoted in the markets a prices which make it a full fledged competitor with other iro and steel. By a modification of the same process, a superio iron is said to be produced at a moderate cost.

The Carbon Iron Co., of Pittsburgh, produce this steel fo bridge purposes, and Mr. John W. Bookwalter, of Springfield Ohio, has interested himself in it with a view to the substitutio of steel for iron in castings for agricultural implements.

Open hearth steel has for some years been quite largel used in compression members, and with good results, but fo tension members, it has been almost impossible to get a steel o high tensile strength which was fairly uniform in quality. Th perfection of this process, however, bids fair to remove thi objection in a great measure.

There is probably no branch of engineering which is as old a bridge building, that can show more progress during the pas forty years. There are few places where this is more obviousl

shown, than at the head of Whirlpool Rapids below Niagara Falls. There, within a stone's throw of each other on the American side, stand two bridges across the most formidable obstacle a bridge builder can encounter; a wide, deep channel, in which a false work is out of the question.

One of these bridges was four years building and an engine and short train go carefully over, while the other was finished in ten months and continuous trains may run at will over its double tracks. The suspension bridge was built from 1851 to 1855, and the cantilever was finished in November of 1883. The cantilever was also considerably cheaper.

Municipal Engineering.

BY THOMAS R. WICKENDEN, TOLEDO, O.

To group under this head all the various branches of engineering that are brought into service, in making our cities desirable places of habitation, would far exceed the desirable limits of this report, and would also trespass on the subjects assigned under other heads.

The department of street pavements has shown very commendable growth during the past few years, especially in the adoption in the large cities of permanent construction. The granite pavements recently laid in Cincinnati are, we understand, fully meeting the hopes of their projectors. The same is true of the first-class Medina sand stone blocks, used quite extensively in Cleveland and other cities, the last mentioned material being somewhat softer than granite, is more readily dressed, and this, together with the natural wear from the traffic, gives a very smooth surface to the pavement, which is very desirable, but whether this quality will eventually prove to be a defect remains to be proven.

For pavements offering the smoothest surface we still look to the various descriptions of sheet asphalt or coal tar distillate, and the city of Washington affords the best examples in this field. Trinidad asphalt is there regarded as the standard, but as a matter of economy in money, they have, within the past two years, returned to the use of coal tar pavements to some extent. The annual report of the Commissioners of the District of Columbia, for the year ending June 30th, 1887, contains a large amount of valuable information on this subject, showing, among other things, that the cost of maintenance for a period of nine years, had not exceeded for the most approved form of coal tar pavement, $2\frac{5}{10}$ cents, and for Trinidad asphalt 2 cents per square yard per annum. Fire brick pavements appear to be growing in favor, judging from the amount laid during the past year in the various towns and cities of our own and neighboring States; their advantages being

low cost, easy construction and good surface. If these pavements are to be permanent, great care must be exercised in the manufacture and selection of the brick. The granite boulders of Michigan are also coming into use in the form of "Telford" roads and dressed boulder pavement, in a few cities, near the region where this material is most readily obtained, the Telford roads using moderate sized boulders for a base covered with courses of crushed boulders of suitable dimensions. The projectors of this pavement make great claims for its smoothness and durability, and practical illustrations may be found in Jackson, Mich., and Fort Wayne, Ind. The dressed boulders are simply broken with smooth surfaces and are offered as being cheaper, as easily laid, and more durable *than ordinary* stone pavements.

The department of sewerage is of equal and, from a sanitary point of view, of more importance to municipalities than pavements.

The rapid growth in public favor of the separate system of sewers, for villages and small cities, is a good indication of its growth in public favor; while the testimony of many of those using the system is the best evidence of its success. This system properly designed and constructed, provides a system of sewers that are clean and of low cost.

One of the most important drainage works now under consideration in Ohio, is the proposed main sewer for the city of Columbus; a sewer over eight miles long, and varying in size from two (2) to six and one half ($6\frac{1}{2}$) feet internal diameter. A full account of its design, and later, its construction, would be very valuable additions to the literature of our Society.

The destruction of garbage and other refuse of the city has been a matter of many experiments of late, especially its destruction by fire produced by the combustion of gases, generated from the material to be destroyed. Fire being the great purifying element, these experiments seem to be headed in the right direction; but from published reports it would appear that the proper application of the principles has not yet been made. The distribution of power and light by means of electric currents, both subtle and deadly, creates the necessity of proper municipal supervision of the construction of the lines for its distribution, which should prop-

erly be under the control of the City Civil Engineer. The multiplicity of wires now used in the cities has created the problem of how to erect and maintain them without disfiguring the public streets. The city of New York has, through its Board of Electric Control, devised methods, and compelled the various companies using wires, to lay them in conduits under the street pavement. A limited number of other cities are following in the same line, and the public everywhere are looking anxiously for the time when streets shall be free from poles and wires.

The proper maintenance of improved streets is a question as yet unsolved in this State. The necessity of breaking into the surface of paved streets may be materially lessened, but cannot be wholly avoided. Perhaps the work of repairing these breaks might, with propriety, be done under the control of the City Engineer, with profit to the tax-payers.

Street Pavements.

SAM HUSTON, STEUBENVILLE, OHIO.

The fine fire brick pavements of Steubenville, from the fact of the low rate at which they have been constiucted, their fine condition, and prospect of durability, have become quite noted, and have been inspected by delegations from numerous City Councils, and are a proper subject for a short paper before the State Society of Surveyors and Civil Engineers.

Two or three circumstances combine to secure construction at a rate that cannot be expected other than in exceptional cases.

First, cheap fire brick. Along the Ohio River, from six to twelve miles above Steubenville, fire clay of the best quality for brick manufacture, occurs in horizontal veins, of fine workable thickness. outcropping near, or but a few feet above, high water mark, and of most convenient access to railroad and river. Outcropping with the clay and in immediate contact therewith coal, of good quality provides a reliable fuel that is always ready for use, if the natural gas used in the valley should fail; some of the works using as the cheapest fuel coal alone. Clay easy of access; fuel of phenomenal cheapness; and down river transportation, furnish brick at the Steubenville wharf at rates to be had in but rare localities. First class brick, owing to competition and cut rates, were delivered at the wharf last summer, at $6.50 per thousand, which is only sixty-five per cent. of the ordinary rate for same class stock, delivered on cars at place of manufacture. The above conditions secured the very low prices for which some of the paving was done last summer.

Second, condition. A natural foundation. Steubenville is built on a gravel terrace, so extensive that part of the piers of the P. C. & St. L. Railway bridge over the Ohio rest on cribs on gravel, as no rock bottom could be secured at practicable depths. This gravel is so porous as to provide absolutely perfect drainage. Waste water from hydrants is allowed to enter the ground ten to twenty feet from cellars nine feet deep, without outlet drains, and

yet such cellars are free from any appearance of moisture in seasons of heaviest rainfall. Where streets are constructed on this gravel bed, the only preparation for the reception of the brick in addition to necessary excavation, is a few inches of clean gravel and sand.

Third condition. Sand, from a dry, elevated bank, at the side of, and on a level with one of the prominent streets, is secured at a minimum cost. The statement of these conditions is necessary; for without understanding them no one could be induced to believe the fabulously low prices for which solid and efficient streets have been constructed.

The following extracts from specifications used will give a clear idea of the method of construction; from these specifications the only variation now made is, that after laying brick, they are swept and rolled with a road roller before, as well as after sanding, for the reason that the preliminary rolling will show any inequalities, which can be relaid without any trouble; this cannot be done after having been sanded and rolled. The preliminary rolling is done with a roller of five tons, which at final rolling is loaded to about ten tons. The roller used has a tread of four feet four inches.

Extracts from specifications: "The street shall be excavated to such depth below the top of the curbstone as may be found necessary, the foundation for the pavement to correspond in convexity, with the top of the pavement itself, so that the paving material may have a uniform depth; it shall be dressed to a uniform and even surface, and made solid as a preparation for receiving the paving material, by rolling with road roller weighing not less than seven tons. Upon the foundation thus prepared there shall be evenly spread a layer of fine gravel six inches in depth, if necessary."

"In paving, the contractor shall keep the foundation work laid to the proper grade, and thoroughly rolled or rammed to the proper slope or shape, at least one hundred feet in advance of his paving, which must be laid in sections of not less than one hundred feet in length, entirely free from gravel, rubbish or covering of any description and thoroughly swept ready for inspection. All rough curbs must be dressed smooth to receive the ends of the

brick. The brick shall be laid between the curb stones and must be of good shape, free from flaws, cracks or breaks; of hard burned fire brick specially burned for street paving, and no bats or broken bricks shall be used except at curbs, where half bricks shall be used to break joints. The bricks must be laid in two inches of clean, sharp sand and at right angles to curbs and kept in even, straight lines, and all joints well broken; must be firmly set upon the foundation in a perfectly upright position, and as closely and compactly together as it is possible to set them. After the brick have been set for a distance of sixty feet, the first fifty feet must be lightly rammed, after which a covering of fine sand, sufficient only to fill the interstices, will be spread over the surface and thoroughly broomed in, after which the whole must be thoroughly rammed, with rammers weighing not less than forty pounds. If necessary a plank shall be used under rammers. As soon as the square shall have been laid as above, a final covering of one half inch of fine sand will be spread over its entire surface, well broomed into joints, and thoroughly rolled with road roller above mentioned. After being rolled by the road roller, the surface must be true to grade and must show no continuous lines or unequal settlements produced by the roller."

"The contractor will be required, without additional compensation, to make good any settlement or derangement in the surface of the roadways or gutters and replace all soft or inferior brick, which may be required within ——— years after the completion of the roadway. The contractor will be required to furnish such laborers as may be necessary to aid the Inspector in the examination and culling of brick. All materials furnished must be of the best quality of their respective kinds, and the work must be done in the most thorough and workmanlike manner, in strict accordance with the specifications, and the directions of the City Civil Engineer."

Under these specifications have been laid forty-nine squares, most of them six hundred feet long. The first square built, May, 1884, on Third Street, between Market and Adams, has been in constant use for heavy traffic; has cost not a penny for repairs, and is now in perfect condition without the appearance of a flaw. The succeeding year (1885) three squares were laid, and the num-

ber has been increased each year, whilst a much larger number of squares are to be built next year (1889) than were built in 1888.

None of the squares have cost the city anything for repairs. The only square repaired by the contractor is on Washington street, over which there flows a constant stream of water. This caused a settling in some places, which, however, can be prevented by grouting the brick when laid with coal tar. whereby the water is prevented from passing through the pavement.

Two or three squares have been laid outside of the part of the city underlaid by the gravel bed. In such cases the gravel foundation is increased from six to twelve inches in thickness. On one of these, before the laying of the gravel, the work being done in wet weather, a shovel handle could be forced down into the subsoil several inches, and when rolling the brick, the seven-ton roller could not be permitted to come to a stop, or it would produce a hollow place in the pavement, and could not be started again. Yet the square has sustained a moderate traffic without signs of failure. It must be remembered, however, where a pavement is to be laid without such a natural foundation as Steubenville affords, and is to be subjected to a heavy traffic, it is absolutely necessary to provide a foundation far more stable and costly than any provided for those of Steubenville.

In a pavement thirty-four feet between curbs, a crown of seven and one-half inches is given in laying, which rolls down to seven inches; the surface a segment of a circle, with curbs seven inches above the outer edges, provides the gutters. The essential items of construction are, in their order of importance, a good foundation; best quality of hard-burned fire-brick carefully selected; broken joints; proper and even crown; and careful placing of the brick.

In addition to the pavements laid by the city, the P., C. & St. L. R'y has laid three thousand two hundred square yards around their freight station at North street.

The maximum cost for paving was that of the first square laid, about $1.37 per square yard of surface. The maximum since has been $1.30. The majority of squares have cost about $1, and some exceptional cases, when fire brick manufacturers were cutting rates, have been constructed for less than seventy cents per square yard, for all expenses.

The streets have given the best of satisfaction, and what is rather unprecedented in works of public improvement, those who do not have the paved streets in front of their property, are urging the City Council to have the improvement made, although ninety-eight per cent. of the cost is assessed on the abutting property in proportion to its frontage. This assessment is payable in five annual installments. The remaining two per cent. is assessed on the general tax duplicate of the city.

The Chair: The subject is now open for discussion. Right here I don't know but I may make a statement about a matter of which I have been somewhat doubtful. A few days ago I was talking with a lady who has spent some time in Rome and she made some statements in relation to the pavements there, which I thought might be of interest, and as she is not an expert observer I feel a little doubtful as to the facts; but I can state it as it appeared to her. She says that the streets in the first place are kept in perfect order and swept as clean as a house floor almost all the time; whenever there is an appearance of dirt in any place there is a man to immediately remove it, and if there is any defect in the pavement it is taken up at once. She frequently sees gangs of men taking up a piece of pavement that she could hardly detect that there was anything wrong. The thing that especially interested me was her belief as to how they were constructed. She says that for instance the street ———, a street built in the new quarter of Rome, and by the way, there has been nearly another Rome added in the last six years; it has nearly doubled the population; however, strange it may sound to us, there is a regular real estate boom there. They commenced making this street something like five years ago, when she was there, and she returned again and was there last year, and she said that first was constructed, as I suppose, something like a macadamized street. They used gravel perhaps two inches or an inch and a half in size, not gravel stones but apparently broken stones, a stone which is found there. It is not broken mechanically; they find it in that shape. These were hauled onto the street for a road-bed and the travel was put on it, and that was kept just as smooth as a pavement. Whenever it commenced to make a rut, and it was a street they had a great deal of traffic on, they immediately filled it with gravel and

smoothed it down, and a very heavy traffic was carried on on it during all this time, and only in the last season, in the summer of 1888, they paved it, and she understood that that pavement was placed right on that bed which they had been five or six years making by travel. I assume, of course, that they must have put some sand or some soft material to lay the pavement in.

Mr. Strawn: What is the pavement made of?

The Chair: The pavement is a very hard stone they have there. It is the stone that underlies Rome. I understand the situation to be this: That whole countries underlaid with what we might call a hard clay; the catacombs, for instance, are cut out of that. When it is cut out it is soft so that it can be worked perfectly smooth and shaved off, but when it has been exposed to the air a year or so it becomes the hardest kind of stone. The Coliseum is made out of that kind of stone, and St. Peters and all the public buildings are built of it. I understand that that is the same. However, I am a little doubtful about some of that. I know it is a fact, for I have heard it from other sources, that that clay becomes stone. That same clay is, I understand, what is known as Roman cement; it is simply ground up or divided finely, and then wet, and it becomes hard stone. I would like to know whether any one here has any information that is more reliable about that.

Mr. Strawn: There is a man on my right here who has been there, and I feel like pressing him to the front.

Mr. Nicholson: I have not since that Via —— has been made. I remarked to my friend that I had been in the catacombs; they are cut in the hillside. It is apparently a sandy formation. We had a little taper of a tallow dip and the light was not sufficient for a perfect observation, but I noticed that these niches were in a perfect state of preservation. I think they were quite soft, not very hard, but the ground in there was quite damp, that is, not wet but rather damp, and in other places it was quite dry. I really could not say much concerning what my friend wants me to speak of, because I really didn't have a good opportunity to observe it.

Mr. Culley: I would like to hear a more thorough discussion of this question of fire brick pavement. A great many of us are contemplating an improvement of this kind this year. About two years ago I went to Wheeling when this thing first came before the

public. I went there on my own account to examine the pavement. I went to the street first paved; the pavement had then been down six or eight years and was in good condition, but in some of the pavements put down more recently I noticed white spots in the pavement, indicating soft brick; now, this is a very serious question, whether we can secure bricks that are homogeneous and hard throughout, or whether the bricks are hard only on the surface, and if it is a fact that they can be vitrified throughout.

Mr. Harvey: I take it that the agencies we have to work against in forming good pavements are moisture and frost, and it is rather questionable, in my mind, whether sand is sufficient in all cases, for a bed for the brick, or pavements of any kind. I think some of the difficulties come from springs beneath the pavement, water coming up from below.

Mr. Weber: A few years ago we put down a macadamized street in our city; I laid four strings of tile under the street, and this street is the best we have in town; whether it was the tile that kept it from wearing out, I do not know; we are going to experiment with brick now, and it seems to me the whole thing lies in getting a good foundation; of course an engineer has to be governed by the surroundings, and if the soil is springy, I think it is a good idea to put in the tile, and if it did not drain it, it would furnish a place for the frost to work, without heaving up the brick; I think there is a good deal in getting brick of uniform quality; I have had good samples sent me of fire brick; some are very porous, and some vitrified throughout very well.

The Chair: We have with us Captain Torrey, of the Asphalt Paving Company, and I would like to hear from him; he has studied this subject of paving a great deal. Mr. Torrey, if you will step forward we will be glad to hear from you.

Mr. Torrey: Mr. Chairman and gentlemen, I do not propose to speak on the subject of Asphalt pavements, but on certain matters connected with the problem of how to determine the cost of pavements as a means of comparing the relative durability of one kind of pavement with another, and also the problems involved in maintenance; before commencing, I would like to comment upon the report which preceded this paper. The gentleman

speaks of the cost of maintaining the distillate pavements in the District of Columbia in the City of Washington. I have examined these figures very thoroughly, and spent a great deal of time in trying to get at the truth, and I find that they are wholly unreliable; if I had a copy of the report of Commissioners, I could show you that where they figure an average cost of less than three cents per square yard that it really runs to about fourteen cents. In the matter of the cost of pavements, the money which it takes to build a road bears the same relation to that road as does the money which builds a railroad bear to that road in future time. There are different ways of getting your compensation for investments in money, different ways of getting returns, but the true basis in making a comparison of cost is the annual interest charged upon the first cost of the road; a street is the same; that is a comparison which is exactly proper and right. The next point is the maintenance of the road. It is customary to speak of a road to say that that pavement stood there so long and only cost so much. Now the actual fact is that, taking the road from the time it was put in good condition when first built until by renewal, repair or any other method of reconstruction you may enter into, you have put it in equally good condition in the future, covering a period of five years or fifty years; that is, taking all the expenses of current maintenance for keeping it in good condition and prorating it to the total number of years covered by it, gives you the annual average of what that road or pavement costs to maintain it. Now, when you have got that figured, you must add that to the annual interest charged on its first construction, and you then have the true annual average expense which that pavement involves. Now, we have for instance, pavements A, B, C and D. If this pavement, A, costs, say a dollar a square yard, the interest on that, say at five per cent., which is probably a very good average for municipal liabilities of this kind, the interest on that will cost every year five cents a square yard; if this pavement, B, costs $2.00 a square yard, the interest charged on that every year is ten cents; if this pavement, C, costs $3.00 a square yard, the interest charged is fifteen cents; and if this pavement, D, costs $4.00, the interest charged is twenty cents. Now, the question of annual maintenance runs into much larger figures than most people com-

prehend, and their determination calls for the consideration of some details. We must assume that the pavement is kept in thoroughly good order; not a pavement that is full of chuck holes, so that a man who drives over it is breaking springs and smashing buggies, and because there is no outlay for repairs, say the pavement is cheap. It has needed expenditures, and we assume in this case that it is kept in good order. The amount of maintenance, as I said before, is made up of the annual expense for repairs and of renewal. Now, the question is, when ought a pavement to be renewed; what is the rule as to when a pavement should be renewed? It is this: Does the use of that pavement cost more than it would to make a new one? It is to be determined by taking into consideration how badly a piece of street work may damage the vehicles that are driven over it. Now, I have seen pieces of pavement that a man could not drive a mile over without injuring his buggy to the extent of twenty-five cents, and there are thousands of miles of pavements in this country that cost two or three cents a mile to drive over them. Now, if that damage amount to over five cents a square yard, it would pay to put in a new pavement at once that cost $1.00 a square, if the damage to vehicles passing over the road in a year amount to over ten cents a square, then it would pay to put in a pavement costing $2.00 a square yard; if over fifteen cents, then one that costs $3.00 a yard; now, in that way, you determine this question of maintenance, and when it is time to renew a pavement because it is costing more to use it than to renew it. Now, the surprising feature in that investigation is, that most of our pavements in the cities are costing more all the time than it would cost to renew them. Now, there is one other element in the comparative cost of pavements, and that is the cost of custody. The requirements of modern life demand that streets be kept clean, and the more satisfactory the affairs of the municipality are conducted, of course the more thoroughly clean the streets are kept; and now the question arises, what does it cost to sprinkle and clean a street? That question of expense is largely the difference between a smooth and a rough pavement. The determination of these facts call for the ascertaining the amount of traffic over the streets. Now then there comes in the question of durability. Here is a man

who says there is a pavement that has been down ten years; yes, and possibly nobody has driven over it; and here is another one that has had two inches of dirt over it, and never had any wear and tear on the pavement. It is entirely childish to talk about a pavement being durable without taking into account the question of whether it has carried a heavy or light traffic, or has been kept clean. You must know all these questions, and you will find that the costliest pavements are, as a rule, by far the cheapest, and that the satisfaction of living in connection with them is something beyond comparison. Now, I have not taken into account what may be the sentimental aspect of the case. There are plenty of people living on a rough pavement, making a very noisy traffic, who would give anything to have quietness, as in the case of sickness in the family; that is a question that cannot be taken into this account. Then, there is the sanitary question. A pavement should be kept free from filth and foul odor. These are questions which are not usually taken into account, but they are more important than all these questions of finance.

Mr. Culley: I think it would be of interest to the Society if Mr. Torrey would give us his opinion of the different kinds of pavements.

Mr. Torrey: Well, gentlemen, if I would say what I think is the better class of pavements, I would say the Trinidad Asphalt.

Mr. Bowen: I would like to inquire of Mr. Torrey why it is that Washington City has better Asphalt pavements than any other city in the country?

Mr. Torrey: I think the gentleman is mistaken in saying the pavements of Washington City are better than any other city. I can point to pavements in the city of Buffalo that I believe are not surpassed by any pavements in Washington. A stranger in Washington gets the impression that the streets are better because they are kept cleaner; a matter which is secured more readily on account of the pavements being connected; it is a difficult matter to keep a clean pavement where most of the vehicles that come on it come off of mud roads close by.

Mr. Culley: Have you made any observations in reference to this fire brick pavement?

Mr. Torrey: I have not made any investigation that I feel that I am entitled to say anything here.

Mr. Weber: There is a question in my mind; take a town of our size, with a population of about 7000, whether it would not be better to cut the streets down to say twenty-five or thirty feet, instead of making them fifty feet, and have a good pavement, in small towns like ours, where we do not have a large traffic. I take notice that in Buffalo where they have this Asphalt pavement, they seem to take a pride in them, and keep them swept clean, and they had a nice grass plat on each side.

The Chair: I understand we have Mr. Reno, the city engineer of Youngstown with us, who has had some experience with brick pavements; we would like to hear from him.

Mr. Reno: I did not come here with the intention of speaking or saying anything on this or any other subject. We have built some brick pavements in Youngstown, and some granite pavements, and some Trinidad Asphalt pavements. We are very much interested in the brick pavement. There are some things in the brick pavement that have not been brought out that I would speak of. In our pavements I find that the frost injures them very much; the brick will freeze and in the spring disintegrate and go to pieces, if they are not very hard. Then I find if they are covered with coal tar that that protects them from the cold, damp air, and they do not freeze. After the tar has left the top of the brick the water gets into the brick, and they will freeze and burst; we have considerable brick pavement in Youngstown; I do not know that I can tell how much just now, but it was built, most of it, on a street that was filled with springs. We graded the street, and allowed it to be hauled over to some extent; we had no roller; then we put on a layer of furnace cinder or slag, that had considerable lime in it; the cinder was hauled on to the street and thoroughly wet with water, and then it was rammed, on top of that, was spread two inches of sand and on top of that the pavement was laid The brick were laid as close together as possible, and at right angles with the street car line; then coal tar, heated to about 250 or 300 degrees was poured over the pavement; the pavement is generally very good except the places that I have spoken of, where the bricks have broken; the bricks that were

broken, of course, were not hardened; then we laid a granite pavement about six years ago; that was laid on a sand bed; the soil is sandy and gravelly, and the sand was taken out of the street and was spread over the street; the joints were filled with gravel and coal tar. The pavement seems to stand very well with the exception of one or two places where there is some settling, otherwise the pavement is very good.

The Asphalt pavement was made in a very excellent manner, and that pavement was the best we had; it is the smoothest and best pavement; there is no noise from that pavement except from the horses trotting over it, and there has not been very much money expended in repairing. A street railroad runs right through the center of the street, and our authorities did not think it best to have it paved between the rails with the same substance, and they paved that with sandstone, and on the outside of the rail they laid the Asphalt up to the rail; I do not think that was a good plan, because the rail moving all the time breaks the Asphalt, and it has broken off in strips along the side of the track; I think if it had been laid with granite blocks against the rail that the Asphalt would have been as good there as on the other part of the street.

Mr. Strawn: How long has that been down?

Mr. Reno: Six years. It has had some repairs, but I don't know that I can state the amount. I think along a gutter of any sort that is laid with asphalt it should be paved with granite blocks, and that should be toothed into the asphalt. Our pavement has not been kept as clean as it ought to be; it has not been taken care of at all, in fact. I don't think it is a very good plan to sprinkle asphalt pavements; the water left on the street all day injures the pavement.

Mr. Strawn: What is the cost of your fire brick pavement, per yard?

Mr. Reno: Including the concrete base or cement, the cinder, it cost about $1.72 per square yard; that didn't include the grading.

Mr. Culley: What should be the character of the brick?

Mr. Reno: The brick should be of regular fire clay, and they ought to be vitrified.

Mr. Strawn: Should they have a glassy surface? Is that what you mean?

Mr. Reno: I do not mean necessarily to have a glassy surface. I know what you mean by vitrified; I mean hard burned brick.

Mr. Culley: How do you know that they are thoroughly burned?

Mr. Reno: Well, that is the question. It is very difficult to tell.

Mr. Culley: The hard point, really, is the selecting of the brick?

Mr. Reno: Yes, sir; that is the hard point. Everybody that makes these brick will tell you that they know how to select them, but I don't think they know very much better than we do.

A Member: What is the actual cost of the brick themselves?

Mr. Reno: I believe about $14 on the ground.

A Member: You can lay how many to the yard?

Mr. Reno: I think it is sixty.

Mr. Weber: What do you think of the idea of dipping the brick in tar first?

Mr. Reno: I don't think that is necessary; of course it would make the brick last a little longer on account of keeping them from the moisture.

Mr. Bowen: There seems to have been more questions asked in reference to brick pavements and the kind of bricks and the probable durability than concerning any other. Now, of course, the character of the brick are about as variable as the sands of the sea. Now, the durability of a brick pavement depends entirely upon the quality of the brick and the method of laying it, the foundation, etc. I think, from the statements made here, that Steubenville is exceptionally fortunate, not only in having a foundation provided, but fortunate in the price they pay for brick. The idea of $6 a thousand for the brick laid down there, as compared with $17 and $18 paid here! which I believe was quoted here last year as the price, and I am quite sure that $10.50 was the lowest price quoted to Columbus men at the kiln. Now, why they can get them to Steubenville, some ten or eleven miles from the kiln, at $6 a thousand, I cannot comprehend. There must be a combine somewhere. Now, with reference to this Youngstown

pavement; to hear the statements made by the gentleman who preceded me, and I think I can account for it in some measure. Didn't you get some of those bricks from Malvern?

Mr. Reno: Yes, sir.

Mr. Bowen: Well, now I had a contract here for paving in the city, two years ago, and I got stuck. The parties who agreed to make and furnish the brick of a certain character, failed to make what they expected to, and I was casting about for brick to fill the specifications. Among others I got samples from Malvern; they were splendid samples. Well, I ordered all that he had and all that he could burn within the next sixty or ninety days. Time passed, however, but no bricks came. His explanation was that he had just then burnt the kiln and that it was not yet cool enough. A few days lapsed and he wrote me that he would like to have me come up. I went up, and I told him at once that the bricks would not answer my purpose. He said he was doubtful; he thought they didn't come up to the sample, and he didn't want to ship until I saw the brick. I told him that I regretted the thing very much; not only on his account, but especially on my own, as I was anxious to get the brick. He said it didn't make any difference at all, for if I didn't take them he could send them to Youngstown, and I suppose there is where the bricks went that broke up with the frost. You want good, sound brick, and I pretend to say that they should be vitrified. Now, I may not comprehend exactly what that means, but I will risk my reputation in saying that the bricks should be vitrified. I do not mean glazed, in any sense of the word; glazing is a superficial polish, but I think that the bricks should be vitrified. Some bricks may be burned too hard and be spoiled, and have blow holes and cracks and all that sort of thing. But, with the best quality of fire clay brick laid upon a good foundation and having the interstices properly filled with sand and cement, I think it is a fair average pavement. Now, I have seen the Washington pavements and I admired them for their beauty and cleanliness. I don't think there is any finer pavement in the country, but our experience here has not been so favorable. Probably twenty-five or thirty years ago our main business street was raised from a graveled road to a paved street. We then put down what we called a Nicholson pavement; that didn't meet the

expectations of the people by any means. I think it lasted some nine or ten years. After that came the asphalt pavement. Now, I don't know whether our friend, Mr. Torrey, would undertake to shoulder the paternity of that street or not.

Mr. Torrey: The gentleman who built the pavement you speak of has left the city, and he states in a letter to me that no asphalt was used in any of this pavement.

Mr. Bowen: That may be, but the asphalt was in the specifications and in the minds of the people. At all events, that pavement was a worse failure than the Nicholson, and when it began to wear out the condition of it was absolutely worse than any graveled road. Now, I believe there is merit in that kind of pavement, when properly laid. We are getting considerable of it on the streets here, and so far as my observation goes it lasts pretty well. Besides this particular pavement on High street, we have it on Town street and a little on Fourth street. That has been resurfaced, probably, on an average, about every five or six years. We have a good deal of stone block pavement. They are the most expensive and are presumed to be the best, the most durable; not quite so smooth, but smooth enough for all practical purposes. Now, we have some boulder pavements here in the city. Five years ago I laid a street on Washington Avenue of about 1800 feet in length, I think, and I don't think there has been five cents of repairs on it since, and it seems to stand as well as when it was put on. About the same time we laid a section on High street, near the depot, of block stones from the Greenfield quarries. It was not laid on the best kind of foundation. The work was directly in front of the freight depot and freight yards of the I., B. & W. Road, and there was such a continuous traffic through there that they didn't give us time to put in a good foundation, but that pavement is in fairly good condition. The stone cost only a little more than half what the granite blocks cost. There is another kind of pavement now coming into use, called the block boulder or split boulder. You simply take the granite boulders, which are a great deal larger than they are for ordinary pavements, say a boulder ten or twelve inches in length, probably, and a corresponding size in width, and they break it in two by striking it with a hammer, splitting it through almost

straight in the middle. They prepare the foundation in the usual way and lay them with the flat side up, and that makes a fairly good pavement.

Mr. Reno: The contractor that received these brick from Malvern condemned them and hauled them off the street right away after they were gotten there; in fact a great many were not hauled on the street at all, and the man who was furnishing them came there and insisted on them being used, and said they were as good brick as were being used in Columbus and Akron.

Mr. Bowen: You didn't lay any of them down, then?

Mr. Reno: No; we didn't lay any of them.

Mr. Torrey: I wish to make an explanation, as some of these gentlemen may not understand this apparent discrepancy of speaking of asphalt pavements. The first were laid in Paris about 1854, and visitors came back full of enthusiasm about the asphalt pavements on the boulevards. Soon after this these coal tar pavements were produced and laid quite extensively. They gave the same kind of a surface—so delightful for all who have occasion to use them—so that it was natural to call it by the same name as that of the pavements of Paris. Well, that was the common name by which they were known at first. I have taken the trouble to hunt up the old specifications in some cities, to see whether they really did call for anything in the way of asphalt, and I never have found one yet, or seen a man who saw anything in the specifications providing the asphalt in the making of a pavement. They were really coal tar pavements. The first asphalt pavements, so far as known, in this country, were laid in Philadelphia, New York and Washington, and finally were adopted by the Government Engineers for Pennsylvania Avenue in Washington, in 1876. From that time it has increased until there are now over 4,000,000 square yards of that pavement in this country. I wish you would keep that in mind when a man talks about the old asphalt pavement, and that it had to be patched every five years, that it was not an asphalt pavement at all.

Mr. Burgess: It seems that the great difficulty in making good pavements is to secure good brick. I want to suggest to the engineers who are not contractors that the best method I know of to secure good brick is to induce the municipalities they represent to pass a guarantee ordinance, requiring the contractor to put up 10 per cent. of the amount to make his guarantee good.

Limes and Cements of Ohio.

BY DR. ORTON, COLUMBUS, O.

Mr. Chairman, and Gentlemen of the Association:

It is a matter of real regret to me that I am obliged to come before this Association, for the members of which I treasure a very sincere respect, without as adequate preparation as I could desire. A year ago, when I undertook to prepare a paper upon the subject which is announced on your programme, "The Limes and Cements of Ohio," I had in mind a series of practical experiments that I hoped to be able to reach during the present year. I speak to busy men who find many of their own schemes postponed through the pressure of work that they have not foreseen, and I need not explain the failure at any great length on my part to accomplish this work. I wish, gentlemen, it were possible for me to use a little of the ingenuity and poetic sentiment borrowed from the geological field which your president has made use of in his inaugural address; but I fear that the subject which I have to present will not bear any such embellishment. It will have to stay in the "dry as dust" catalogue, and you will have to take it as you find it.

I speak with pleasure to this Society upon the subject which is before us, because you are the men who have the opportunities to acquire the practical information which we need in settling some of the questions of scientific interest that stand connected with "Limes and Cements." But, without further introduction, let me call your attention, in the first place, to the limes of Ohio. I will not undertake to make an exhaustive statement; I have placed a small geological map of the State before you, with the details of which I know you are acquainted, and I will ask you to bear in mind that the western half of Ohio is occupied by several great limestone formations, of varying thickness, that rise to the surface in the areas that are represented by the different colors upon the map. Now, in investigating the limes of Ohio, let us begin with the bottom of the scale.

In Southwestern Ohio there are a dozen counties, more or

less, that are occupied by a very well marked limestone formation. It is the Cincinnati group or Hudson River group of the scale. There is a single outcropping of another formation within this area which has, during the last four years, become very famous through Ohio and adjacent States as the Trenton limestone. The outcrop to which I refer occurs a few miles above Cincinnati in the valley of the Ohio River, but all the rest of this southwestern corner of the State is occupied by the Hudson River group. It is made up of sheets of blue limestone, two to four or six inches in thickness, separated by layers of fine clay shale, sometimes called marl; blue clay designates it very well. Now, these limestone sheets are capable of being burned into lime. This was found in the early occupation of the country; it was the outcropping edges of this formation which, in early days, furnished the only source of lime in Southwestern Ohio. If we take this Hudson River series and examine the limestone in its best condition, we find it to be composed of about 90 per cent. carbonate of lime and about 5 per cent. carbonate of magnesia, with impurities ranging at 5 per cent. The lime will be dark colored by reason of the impurities—the aluminous and ferruginous material, or in other words, the iron and clay that are present in the limestone will give that result. They may also add to it certain peculiar excellencies which I will not dwell upon now. The next group above is the Medina formation. It contains no limestone worth the name. A little cement could be obtained from it, possibly, but we will pass that at present. The next formation that rises to any considerable importance is the Clinton limestone. It is not definitely indicated upon the map. It makes the margin of the division which you recognize here (pointing to map). All this portion of the State marks the Niagara formation, and around the southern margin we have an outcropping of various breadth of the Clinton limestone. This Clinton limestone is very interesting in all the phases of its history, but in connection with lime, it is only necessary to say, that it contains 84 per cent. carbonate of lime and 12 per cent. carbonate of magnesia; this will give the general average of its composition. It rises, however, in exceptional localities to 95, 96, 97 and 98 per cent., and is in these exceptional localities by far the purest carbonate of lime found in the State. These localities, I will call

your attention to presently, or perhaps I may say now, that along the borders of Mad River we get a number of deposits of this character, and also in the valley of the great Miami and its tributaries; there are outcroppings of this phase of the formation at Brown's Station, near New Carlisle, and also on the borders of Clark and Miami counties. Near Eaton, in Preble County, we find large exposures of this Clinton limestone. It does not calcine very easily. It resists fire better than many other stones, and therefore has received a local name, for which we are scarcely prepared, viz: that of firestone. It has been used to lay up the arches of the sugar camps, and also for boilers, chimney jambs, and the like of that; some of it is very white and burns into a white and strong lime. Next above the Clinton limestone is the Niagara shale, but the only element of it I need to name here is the famous Dayton and Xenia stone, familiarly and favorably known as the Dayton limestone. It contains 92 per cent. of carbonate of lime and about 6 per cent. of carbonate of magnesia. You see it is substantially identical with the formation with which we began, and though there are very great differences in the character of the rock in appearance and its adaptations to the various uses we make of it, the chemical composition remains nearly uniform. Next above the Dayton stone comes the great Niagara series. The Dayton limestone belongs within this series, but the Niagara, in its upper division, which is also named the Guelph division of the Geological scale, occupies that large part of the area which is represented by this color on the map. (Pointing to map.) A large part of it, perhaps $\frac{9}{10}$ of the outcrops are occupied by that formation. When we come to it and find it in its characteristic phases, we have reached a very different looking rock from what we have seen before, viz: a porous rock that has a composition of about 54 per cent. of carbonate of lime, and about 43 per cent. of carbonate of magnesia. It sometimes rises a little beyond these figures in its best exposures. The percentage of impurities will run down to less than 1 per cent. for large districts. Here, then, we have a great body of lime, an enormous area as compared with the use that lime can be put to, areas stretching out for miles and going down to depths of a hundred or more feet in places, in which this composition is steadily maintained 54 or 55 per cent. of

carbonate of lime and 43 per cent. of carbonate of magnesia. The stone, in other words, is a dolomite, a magnesian limestone, the carbonate of lime and magnesia being now in about atomic proportions. Above the Niagara comes this series on the map which occupies a larger area than any other limestone in the State; we call it the Lower Helderberg series. It has been found through the recent drillings that have gone forward in the State, to be at least 600 feet thick in Northern Ohio, but to the southward it grows thinner, and falls to less than fifty feet in total thickness in some sections. But over all this portion of the State through Allen and Hancock counties and to the eastward, also, we find this great thickness. It carries within it beds of plaster, gypsum, and spars also, of various sorts. It is lacking in fossils; the lower part of it exactly agrees with the Niagara limestone in composition —55 and 43 per cent. of lime and magnesia, respectively. You can not draw a line between the two limestones where they come together, and into many a limekiln the stone is quarried from both and put into the limekiln together, and no difference can be found between the products of the two. The Lower Helderberg sometimes becomes, in its upper portions, a blue and stubborn stone, quite silicious and aluminous, and then makes a very inferior quality of lime, in fact, rather a cement than a lime. It was formerly thought that this formation contained the famous Louisville cement, but this has been found to be a mistake. The water lime of the Eastern States, which was used in the building of the Erie Canal and that has been employed in all the government works along the sea-coast, comes from the bottom of this great series, but, as I will show you after a little, there is no special significance in that fact. If you have a sheet of limestone for a hundred miles or five hundred miles, you have a chance for a great many changes to occur in its composition. It may be a cement rock at one place and a good limestone at another. The Lower Helderberg limestone, taking 100 or 200 feet of the series where it is thinnest, has the constitution that I have described, viz: that of a pure magnesian limestone, but the upper portions of it become stubborn and indestructible, and are not burned to lime, as a rule. Next above the Lower Helderberg limestone comes a belt which you can hardly distinguish on the map. It is called the

Corniferous or Upper Helderberg limestone. In this we have a series of very considerable interest. It is not over 100 feet thick, all told, but there are a number of varieties of limestone that occur in it. At the bottom of the series, we have a few beds ten or fifteen feet in total thickness, the composition of which is about 57 per cent. carbonate of lime and about 35 per cent., we will say, of carbonate of magnesia. The Upper Helderberg series begins with this composition; then we come to another stage a little above the one first named, which contains about 65 per cent. carbonate of lime and about 30 per cent. carbonate of magnesia. Next come beds containing 75 per cent. lime and 20 per cent. magnesia, and finally we reach beds containing 85 and even 95 per cent. carbonate of lime with a very small percentage, 2 or 3 or 4 per cent. of carbonate of magnesia.

The Upper Helderberg limestone is thus seen to be, in its highest courses, a tolerably pure limestone, reaching 95 per cent. carbonate of lime in its best phases. We have twelve feet of it in the Columbus quarries that can be quarried by itself that will show more than 90 per cent. carbonate of lime.

Now, then, I have passed in review the limestone of half the State. I must glance at the remaining formations of our geological scale. We come next, after the divisions already described, to a mass of black or blue shales 250 to 300 feet thick, that make the margin of Lake Erie, and that can be followed in the Worthington and Westerville and Chillicothe shales as far south as the Ohio River.

Next, we have the great Waverly series, which is not less than 600 feet in total thickness. These two elements, the black shale and the Waverly group, are without limestone; at least they contain no important deposit. We find a little cement at the bottom of the blue shale, but no lime fit for burning. When we come to the Coal Measure series, or Carboniferous formation, we find a number of limestone sheets built into the column. This column contains a great many elements, and it is not necessary to review them here The Coal Measures are built up of beds of sandstone, shale and limestone, with coal, fire-clay and iron ore interspersed irregularly. So we have the Ohio shale with no contributions to lime; the Waverly group with no contributions,

the sub-Carboniferous limestone with insignificant contributions, and the Coal Measure with no contributions to the lime of the State, as far as the general markets are concerned. You see that our limes all belong in the areas that make up the western part of Ohio.

Now, what shall we deduce from this series of figures before us? (referring to the figures on the blackboard, representing the composition of the different formations). I think you will agree with me in saying that Ohio is well supplied with lime. Ohio can select for itself such limes as it wants. If it wants dolomite, with 54 per cent. lime and 44 per cent. magnesia, it can find it in the Niagara; if it wants lime of 90 per cent. and over, it has the Dayton limestone to rely upon; the Clinton limestone also coming close to that figure, and the upper division of the Upper Helderberg limestone.

How do the books classify the limes which are represented in this series which I have brought before you here? The most authoritative treatises we have classify them according to the amount or percentage of carbonate of lime they contain. I remember that Gillmore, who is perhaps our highest authority upon limes and cements, leaves us to understand that the value of a lime depends upon its percentage of carbonate of lime. The limes are characterized as rich upon the one side and poor on the other, as fat on the one side and lean upon the other, as strong on one side and weak on the other. The rich limes, fat limes or strong lime are limes of this last named character that run up to 90 per cent. carbonate of lime. They are also called hot upon the one side and cool upon the other, and the books give you to understand that the rich limes, the fat limes, the strong limes and hot limes are the limes that the builder is to choose. Whenever he is able to make the choice he must select the limes that have this character. That would leave out a considerable part of our supply; it would leave out the limes of the Niagara and Lower Helderberg; it would leave out the lower portion of the great Upper Helderberg series and would confine us to supplies of which we still have plenty. We have enough to meet all demands if it is desirable. That is the view of the limes that is given in our text books. But what is the classification with which you have

miliar? how do you who make use of limes in the large way mate and distinguish these various groups? Why, I think de in our common practice, the limes of the State into four groups. I do not say that you have this composition in mind as you make the classification, but the markets of ate classify them in about these groups. There is the first containing 55 per cent. carbonate of lime and 43 per cent. ate of magnesia; a second, with 65 per cent. of carbonate and 30 per cent. of carbonate of magnesia. A third group is about 75 per cent. carbonate of lime and 20 per cent. ate of magnesia, and still another group ranges from 85 to cent. of carbonate of lime with 2 to 10 per cent. of car- of magnesia. Now, then, these are the limes that come e markets of the State, the limes of this character. Let me to you some of the sources of supply of the limes of the ass; Springfield lime belongs here. It supplies Cincinnati aches far down the valley of the Ohio. It finds its way as th as New Orleans and follows up some of the tributaries great river. Sidney, Cedarville, Yellow Springs and Cov- are towns where lime of this grade is produced to some erable extent for the general market. But the great supply from the north, from Wood and Ottawa counties and the connected therewith, with Genoa, Fremont, Rocky Ridge, Sun and Gibsonburg as centers. The limes of Hancock, Allen Vyandot counties belong here. Now, when we have named sources we have a considerably larger production than is to nd in any of the other divisions; in one exceptional locality, v Paris, Preble County, has been found that the lime pos- a different character from that of the great stratum to which ngs, but this is the only point in the State where this excep- phase occurs in the Niagara rocks, The composition of this 65 per cent. carbonate of lime and 30 per cent. carbonate gnesia, placing it in our second division; it is of good char is manufactured on a large scale, and goes out on the ds through the country far and wide.

The lime of Marion, from the Upper Helderberg formation, gs also in the second group of 65 per cent. limes. The third on takes in the most of the Marblehead and Kelley's Island

limes. They range between 75 and 85 per cent. of carbonate of lime. The fourth division of 85 to 95 per cent. lime takes in the Clinton limes of Southern Ohio, the Dayton limestone of Ohio, if any person chooses to burn it, and the upper division of the Upper Helderberg. This last is found here at Columbus and also at Kelley's Island and Marblehead, but it is mainly rejected for lime at the last named points. As a matter of fact, there is but one large production of Northern Ohio that takes in the 90 per cent. lime, that is the Olemacher lime of Marblehead.

These, then, are the limes of the State that are reaching the markets and meeting the wants of our people. How shall we classify them still further? Are magnesian limes, which our books count poor and lean limes, inferior to those which are rich in lime? As we ascend in the lime scale, do we find a constant increase in value for the builder's purposes? These are important questions. What shall be the test? Shall the test be the amount of mortar that the lime will make? The magnesian limes, when they slack, will increase in bulk about 200 per cent. The limes of the succeeding divisions will increase from 250 to 350 per cent. in bulk, that is, you will have a larger percentage of white coat, and of putty coat from the higher limes; you will have a larger bulk of lime to mix with the sand and a larger amount of mortar, I suppose. There is just the line where we need the more careful experimentation; where the practical man must come in to carry out the inquiry. I have tried to call the attention of our bricklayers to this question and have interested some of them here in Columbus to inquiring, but it requires a careful watching of the work and a little trouble to make the results of any great value to us. The amount of mortar, I suppose, may be greater for the richer limes, the amount of putty coat is certainly greater. I suppose the amount of sand that will be taken up is greater with these limes of the upper division. But when it comes to other points, we find the advantage apparently left with the magnesian limes. These are the cool limes. They do not set rapidly. There can be a larger spreading of mortar made with safety with these limes. You can lay twice or three times as many bricks with one spreading of mortar of limes of this group as with the limes of the highest group, and there seems to be a progressive change

according to the chemical constitution that is noted here. Well, the amount of mortar that can be made would be one question; how far the lime would go, that would be a test of value; but have we any other test? I think that the test that the engineer would be apt to use would bear upon the durability of the mortar. Now, I should like very much to get some reliable data in regard to the durability of these limes, and I do not know anybody that can look this up better than you. You are familiar with the localities that have used one or another of these limes. For instance, Columbus has been built up with 90 per cent. lime, and probably our friend, Mr. Bowen, can tell how the mortar of Columbus stands as compared with that of other cities. Cleveland has been built up with 75 per cent. lime, mainly, and up to 90 per cent., that is, with Marblehead and Kelley's Island lime.

Within the last few years the Marion lime has found its way in to a considerable extent. Springfield, on the other hand, has been built up exclusively of 55 per cent. lime. There has never been anything else in Springfield but that. Now, then you can take Columbus and Springfield and go back to the old masonry and see what story it tells, which stands best in the aggressive atmosphere that coal has given to all our towns in later years. Go to Cincinnati and you will find there the 55 per cent. limes; you can't sell anything else there but these milder limes. Here in Columbus, where 75 and 90 per cent. limes have been used during all the past, we find these milder limes working in; Carey and Cedarville limes, and Marion lime is also taking its place here among us, and some of our best builders are making use of them. Now, my own observation has not been methodical enough to make it valuable, but so far as I can see or have observed, the test of permanency is in favor of the limes of the greater percentage of magnesia. I think the brick work of Springfield shows better than the brick work of Columbus, for example, the older work; of course, other things come in, the quality of the sand, the standard which masons have been obliged to maintain in their work; all these questions come in, and all these elements would need to be eliminated before we could reach a permanent conclusion, but it looks to me as if the argument was rather in favor of the magnesian limes, as far as the durability is concerned. I recall the example

of Antioch College, which was built in 1862; now, then, I have known these walls for twenty-five years and I have not known the time when it was not as easy to drive a nail into the brick as into the mortar of these walls. It was this lower group of limes that was used here, and they had set and held in this firm fashion; there, however, was a clear country air, without the destructive action of city smoke to act upon the lime. The chemists tell us that the magnesia of the lime would be the one to give way first in the corrosive atmosphere of the city, but that is not my own observation.

Gentlemen, I am wandering over too much ground because I have no manuscript, and I must not pursue this subject further. I have called your attention to the limes of the State and their chemical composition, and to four great divisions that are found within these vast boundaries of possible production. I have spoken of the uses of the lime as confined to mortar, as this is the use with which you are perhaps most familiar; but for all caustic work, as paper making, the richer limes are probably the best. The hot limes of the upper division have more caustic energy. The value of limes for glass making is not dependent so much upon their chemical constitution as their whiteness and freedom from all troublesome impurities. A large part of the plate glass manufacturies of Pittsburgh draw upon our Niagara limestone for their lime supply; and the new glass manufacturies of the northwestern portion of the State and also of Indiana are dependent almost exclusively upon these limes.

My subject also calls for a discussion of the cements of Ohio on this occasion. I have occupied almost time enough; but let me give you a few words upon the subject of the natural cements of the State, which I have already named by implication. What is a natural cement? A cement is a limestone that has been unfortunate; a limestone that instead of being made in good form and of proper materials, has had some bad luck by which a little clay or a little silica has been distributed through it, and if the proportion in the accidental corruption of the lime is of a certain sort and if it shall be handled in a certain way and burned to a certain temperature, the result may be a hydraulic lime, a lime that will set under water. Now, if a cement is simply an impure

limestone it is quite likely we shall find in this extended scale which I have led you through, a good many examples which will answer this purpose. If there was any demand for these natural cements we could find them anywhere. I remember to have heard that when the Sandy Canal was being dug fifty years ago, through Columbiana County, and there was a necessity for cement, they went to the Coal Measures, near by, and burned the Mercer limestone which they found there, and the work stands to the present day. The locks were never used. I believe one boat was locked through, but the cement still holds the walls together and honors the quarry from which it came. If you needed natural cement, you could go to the Coal Measures and get it. Now, then, following again our geological column, we find that we can get cement all along. The specifications of the commissioners of the southern part of the State require that the abutments of bridges shall be made with Cincinnati lime. I do not know that it is because this is cheaper lime; I think that another reason could be given for the selection. These limestones carry with them some of the clay that I have spoken of as separating the layers of the limestone, and when this clay is burned with the lime it gives a hydraulic property to it. In the lower portions of the Niagara system near the Dayton limestone, we get a good many courses that can easily be turned into good natural cement. I had an analysis made a number of years ago of a blue rock which we call the Springfield blue-stone; it had a composition that agreed almost exactly with that of a hydraulic lime of France, and putting it to the test I found that there was a particular stratum in the Springfield quarries that could be made to answer a good purpose as a cement. The hydraulic lime of France finds a great and extensive market, and this material almost exactly agrees with it.

By the work of your profession, roadways have been laid to every cement quarry which we wish to reach, and the rates are so low from the great centers that it does not pay us to develop any of these out of the way sources. Ohio is full of possible cement rock. We have made hydraulic lime on a small scale in Fayette County, east of Washington C. H., in the edge of Ross County, in the water lime group that occurs there; but there is no need of naming any one locality, for in every county where the formation

occurs, we could find beds that would give a moderate quality of cement. The trouble that is inherent in all natural cements is the changeableness of the quality; the accidental features come in to mar the value of the product. It is only now and then, as in the great Louisville cement beds, that we find series of deposits spreading over a comparatively wide area that seem to be absolutely homogeneous in character, and when we come to beds of that character we can build our cement works upon them and distribute a cheap quality of cement through the country.

We do not find the exact equivalent of the Louisville cement rock in the Upper Helderberg division of our own State, but I have no doubt that we could find in the quarries of Columbus, rock that, if it were enough to our interest to burn it, would turn out a reasonable quantity of cement, though nothing on which a great manufacture could be based at the present time. When we come to the great Coal Measure series, there, with two or three exceptions, we find materials for cement manufacture in all the limestones, and the manufacture has been carried on to some extent in this State at Bellaire and at Barnesville, and at New Lisbon in the Coal Measure limestones. Some of you, I have no doubt, are familiar with the New Lisbon cement, made from these thin sheets of limestone which must be mined as coal is mined, viz: in drifts, to secure the limestone which is to be turned into cement.

I thank you for your patient attention; I have wandered over a good deal of ground, and I suspect that I have said but few things which you were not already familiar with, but if I have put the subject into any shape in which it will be more interesting or intelligible to you, I shall be amply repaid.

Mr. Bowen: The only thing I think necessary in following out this subject is some practical data as to the use of limes and mortar, the various methods of using them, and which is the best method. There is a great deal of inferior work done, both in mixing the mortar and the manner of keeping cements in store, by allowing lime to become mixed up with dirt and the use of an inferior quality of sand. This should not be tolerated. There should be some method of determining the difference between good

mortar and bad mortar. The careless mixing of mortar is greater than is generally understood. It is a very common method in these busy times for a man to mix mortar one day and put it on the next. If it is frozen in the morning, put a little hot water on it and have it ready for use. All this carelessness is at the expense of good work. We ought to have some series of experiments in this direction, I think it would be useful to members of the Society and to builders in general. It was my purpose last year, when I conceived the idea of saying something on cements, to follow it up this year with a series of experiments. I got a lot of specimens from different manufacturers throughout the country and made up a lot of blocks or bricks for the purpose of testing them so that I would be able to arrive at some definite conclusion about this matter, but unfortunately all my bricks went into the gardener's cart one day, to my surprise and disgust, and I will have to defer this matter to some future time.

Mr. Orton. What has been your observation with regard to the old mortar of the city as compared with other towns?

Mr. Bowen: I have not observed the brick work of other cities suffiently close to give an opinion.

Professor Orton: What would be your judgment as to the durability of the mortar of Columbus?

Mr Bowen: Well, I think they are a fair average, but there is such a wide range as to their quality that it would be hard to fix a standard. I think the difference is more in the methods of handling the limes than in the limes themselves. As a rule the limes seem to stand well. In the masonry for the Broad street bridge, which was done, I think, as far back as 1832, when it was removed three or four years ago, it was almost like a solid rock. A great part of it had to be blown up with powder. So far as I could judge there was nothing but the common Columbus lime used there.

Mr Strawn: It interests me to listen to one whose head contains the rocks of this State so perfectly and who knows so well where the limes and cements come from. He referred to the cements used in the old Sandy and Beaver canal locks, where the engineers seemed to take pride in seeing how many locks they could get in the canal. My friends in that vicinity thought there

was a great fortune in these old locks, they seemed to be so perfect in form the entire length of the lock; so a friend of mine purchased a set of those old locks, and when he undertook to tear them down, he told me he would sooner go into the quarry and undertake to make money in quarrying the stone outright. He said he could not wedge them apart without defacing the stones so that they would have to be redressed. I have seen parts of those old canal locks where the stones had been taken apart, where they had spawled off four or five inches in length, spoiling the stone entirely. These cement works in Columbiana County are not run for the purpose of making cement mortars, but for filling fire proof safes, and you would be surprised to see the hundreds of car loads that go away from those works. I can't exactly agree with my friend Bowen on this subject of mortars. I am very sorry, since he has given us so much valuable information upon this subject, that he could not give us the result of these investigations in regard to the careless manner of using mortar. I have observed that in the old buildings of our place that have been torn down that the bricks were really not worth cleaning. It took more time to clean the mortar off than the bricks were worth. We had a very shocking calamity a year ago in the falling of the stack of our new water works. The core of the stack was built of soft brick, and there was one thing noticeable in the falling of the stack, which killed one man and wounded two others very badly. I was there an hour or so after the falling of the stack, before the rubbish had been removed, and there was not a single brick with a particle of mortar sticking to it. The mortar looked to be of fair quality, and looked to have a sufficient quantity of lime in it, but you could take a piece of it in your hand while dry and crush it. There was something wrong with the mortar. I made some little experiments. The brick were very dry and adsorbed a great quantity of water, and they didn't dampen the brick sufficiently. It seemed that the moisture in the mortar was at once absorbed by the thirsty brick and left nothing but the two dry elements that had been mixed together, and there was no bond left. Another thing in regard to the quality of the sand. The lake sand is not regarded as good sand, although it is clean. If you examine it under a glass you will find the sand is nothing but little round pebbles

at any angles, and the mechanics say that it does not make a lass mortar. There is certainly very great need of arriving he data which shall indicate to us what quality of sand to use.

Mr. Bowen: As a matter of fact, in that stack, were the bricks ry?

Mr. Strawn: I think there was some water thrown on them, hen they went into the stack they were practically dry.

Mr. Bowen: The softer the bricks the more water they would b?

Mr. Strawn: Yes, sir; the core was built mainly of soft brick hat was doubtless one of the causes of the accident.

Mr. Lewis: Before leaving this subject I would like to inquire r. Bowen, or any of the rest of our practical men, their n of laying a high wall with green mortar, that is to say, ng a wall up rapidly. What influence has it on the final y of the mortar in the work?

Mr. Bowen: I suppose there is a limit, but I think the limit within the capacity of men to build walls so that if the bricks sound and well wet as the specifications usually require, and ortar of good quality, it would set about as fast as the men l ordinarily build on top of it, so that by the time they would xty or seventy or eighty or one hundred feet high, the lower ould be sufficiently set to sustain the weight, especially when ke into account the factor of safety that should invariably be led in all such work.

A Member: I would like to ask Dr. Orton which one of these would furnish the best flux?

Dr. Orton: The upper group without any question. There me modern processes of iron working which contemplate the f magnesia limes, but all the ordinary processes depend upon gher carbonates of lime.

Mr. Strawn: And as a fertilizer, which?

Dr. Orton: The upper group, I suspect. The magnesia limes not been supposed to have been successful in that way. The esia is said to exert an unfavorable influence and to be pois- to some extent, but I have known the magnesia limestone ve been turned to good account.

The Chair: I don't know that I have any practical suggestions

but I think what Dr. Orton has said should be thought of a little more. He asks for experiments, and I suggest that you bring to him the results of experiments and assist him.

Mr. Strawn: I would like to ask Mr. Bowen in regard to the quality and the kind of cement and manner of mixing the mortar and applying it, in the matter of laying sewer pipe in this city?

Mr. Bowen: Well, I have never had a very great experience in that, although I have had some. So far as my experience is concerned, we just mixed the cement without any sand and where the pipe failed to fit closely we would put some cement in it, and if it fit closely, less or possibly none; but as a rule, I don't think I would risk anything by saying that the cement is almost entirely in the specifications.

Mr. Strawn: I would ask whether the specifications in those cases would stick?

Mr. Bowen: They usually stick long enough for the contractor to get his money; by the way, that reminds me of the brickmason who built a bake-oven with this same idea, apparently, in his mind. There were two of them, one on the inside and the other on the outside. The one on the inside called to the one on the outside, "you go in and get the money while I hold the arch."

Mr. Griggs: I have thought sometimes, in using hydraulic cement, that if the sand was very fine, that the quality of the work was not as good as if the sand was coarse. I have never examined the sand to see whether it was round or angular, but I know that sometimes one kind of mortar is not more than half as good as another mixed from the same barrel. I don't know why it is.

Dr. Orton: What is the use of sand in mortar?

Mr. Strawn: To cheapen the mortar.

Dr. Orton: Is the use of sand in lime mortar the same as in cement mortar.

Mr. Strawn: It would seem in practice not.

Dr. Orton: Is not the use of sand in lime mortar to make the mass porous, so that the air can reach the interior? Lime mortar is an artificial stone and is formed as we say, by the action of the carbonic acid of the air on the lime. Now, does not the sand of the lime mortar answer that purpose? But in the case of cement,

isn't the true answer that it is merely to extend the mass and cheapen the material?

Mr. Bowen: There is another answer in regard to limes that is probably correct. Take a mass of lime of any considerable size and as it dries it has a tendency to contract, and by the contraction it cracks. Now, if it is mixed with any medium that will unite it in the inner layers and draw together these particles so as to form a mass without developing these external cracks that might be one object; that would be a mechanical explanation, and your chemical theory with it would probably cover the ground fairly well.

A Member: We are told that in the process of coloring, the object of one substance used is to bind two other substances together. Now, I will inquire, does not sand act in that respect?

Dr. Orton: I don't suppose there is any chemical change goes on in the sand. The sand comes out from the old mortar sand still. If you have a sharp surface, sharp corners, there would be perhaps a chance for the crystals of carbonate of lime to attach themselves more frequently than if they were lacking.

Mr. Strawn: Kind of retaining points?

Dr. Orton: Yes, sir.

Mr. Strawn: Is not mortar a hydrate of lime?

Dr. Orton: It is when it begins. It is first a hydrate of lime and then it slowly gains carbonic acid from the air and turns into a carbonate.

Dr. Orton: I would like to ask the question, what the burning of lime consists in? The question was asked me not a great while ago and I had to plead ignorance. I hope my friend Mr. Bowen can answer that question.

Mr. Sager: I would like to ask Prof. Orton, what property is given the lime when it becomes air slacked?

Dr. Orton: The air slacked lime is a carbonate; it has secured the addition of carbon.

Mr. Sager: And after that change it does not make good mortar?

Dr. Orton: No, sir.

Pile Protection.

BY J. A. PRITCHARD.

Mr. President, and Brother Members :

GENTLEMEN—Being a new member, it is with some hesitency that I present the following to the consideration of the Society: Having received a letter from our Secretary requesting me to read a paper before the Society, my answer was, "That as I had not been connected with any work of importance, I knew of nothing which I thought would be of interest to the members, as the greater number of them were older in experience than I, but that I was willing to try and bear my part of the burden of entertainment, and as there had been some pile protections placed along our (Darby's) creek to prevent the washing out of levees and banks, I would attempt to describe them as best I could in regard to their construction and cost." I thought my answer would possibly excuse me, and that I would be a listener and not one to be heard; when, to my consternation, I received his reply that "Facts were just what was wanted," and to "prepare the paper."

Darby's Creek, through Pickaway County, is a very crooked, rapid running stream, with banks of a loose, sandy soil mixed with gravel and ripples at every few hundred yards, some of which are as much as a hundred yards in length. In former years, before the drifts had been cleared from the channel and tile drainage had assumed its present proportions, extreme high waters were quite frequent; but in the past eight or ten years it has not been out of banks, except two or three times, and then only in the lower places; and it has been my observation that erosion was greatest when bankfull, or nearly so, than when it overflowed. It has been a study with land owners along the streams (I would add here by way of parenthesis that I refer to those who believe in taking care of land, and not those who allow things to go to rack) to devise some effective and cheap method of protecting banks and levees. Some have tried to do this by building cribs of round timber and filling with brush and boulders. This caused the wash to be more instead of less, and were considered failures. Others have built brush dams, excavated new channels and changed the course of the stream. While one attempt at this was successful others

failed, and the expense of making a new channel was considerable. In the fall of 1887, there was commenced a system of pile protection, of which there was put in at that time 742 feet in all, which consisted of three wings, and 546 feet, which was in one continuous curve of about 475 feet radius, the piles of which were driven close up to the bank and sheeted on the water side with two-inch oak sheeting. But it is the wings that I wish to speak of. As to place a continuous sheet along the water front of a large farm that is liable to wash would be rather expensive. The wings are constructed in the following manner: No. 1 is located where the creek makes a curve of 800 feet radius and consists of thirteen piles seven feet from center to center, seven of which were driven close up to the bank. The remaining six were placed across the stream at an angle of 45°. Brush was then laid across the line of piling well out into the stream. The bottom plank of the sheeting was then forced down on the brush and made fast by six-inch wire spikes. The sheeting was placed behind the piles on the bank part and is held in place by a back filling of brush and gravel. On the part which extends into the stream, the sheeting is placed on the front or upper side, and is secured to the piles by six inch wire spikes. The top piece of sheeting is made double, and in such a manner as to break joints, and is bolted with half-inch bolts, two to a pile. The extreme thirty-five feet which extends into the stream is double sheeted, and in such a manner as to break joints between the piles, and is bolted at the joints to a four-inch by six-inch stay, placed behind the sheeting, with half-inch bolts. The piles were driven by horse power with an 800-pound hammer. The leads were placed on a common farm wagon and were about sixteen feet full length. The length of this wing is eighty-four feet. An estimate of the cost would be:

Thirteen piles, fourteen feet long @ $1.50	$19 50
Driving same @ $1.50	19 50
Boarding three men and team	5 00
Sheeting, 1320 feet B. M. @ $68 per thousand	24 90
Placing sheeting and back-filling	10 00
Bolts and spikes	3 00
Total	$81 90

I would here say that the cost of the whole 742 feet was between seven and eight hundred dollars, or about one dollar per foot. The effects of this wing has been to protect the bank for about 400 feet, at which point the wash originally began, on the opposite side, but since the wing has been placed has begun further up the stream. It also had the effect of deepening the channel, which before was about two and one-half feet and now is four and one-half feet deep. Wings Nos. 2 and 3 are built in the same manner, but with a more favorable location and twenty-eight feet less length in bank part. No. 3 failed, the stream end having washed out when the ice broke up in the spring of '88. The depth of the water where it stood is now about eleven feet. Wing No. 3 is 190 feet below No. 2, and the current does not strike the bank between them, although they are on a curve with a radius of 475 feet. One hundred and sixty feet from wing No. 3 the continuous sheeting begins. My opinion is that the better practice would be to cross the current at an angle not to exceed 20°, and continue the wings twenty to thirty feet further, according to circumstances, and the piles should be longer than those used in this case, and be driven lower so that when the ice breaks up, that with a moderately high water, it could flow over the top of the wing. And there should be two piles driven from eight to ten feet back of the wings, and two heavy round timber braces placed at the end pile and the third from the end to insure stability, as the weight sustained during an ice gorge is tremendous. I am not aware that any engineer was called on to plan or locate the work that has been done, but I think that by being properly located that a wing not to exceed a cost of eighty dollars can be made to protect a bank from 200 to 500 feet, according to the curvature of stream where located.

A Curved Dam.

BY ————————

As almost every engineering journal for some time has been discussing the subject of "Curved Dams," we thought that the members of the Society might be interested for a few minutes by the description of a curved or semi-circular dam at Greenwood Lake, near the City of Delaware.

Sugar Run is a small creek, or run, that has cut its way down into the slate or shale until it has worn a gully from ten to thirty rods wide and from forty to sixty feet deep.

About one hundred rods above the point where this run empties into the Olentangy River, the Delaware and Mt. Vernon road crosses this gully.

At this point the County Commissioners built an arch culvert several years ago. This culvert is eleven feet two inches wide, eleven feet high and forty-two feet long, and is built of limestone from the quarry west of Delaware. The wing walls were about two feet thick, fifteen feet long and twenty-four feet high when they were first built. The filling and embankment were made of boulder clay from the sides of the ravine.

In 1871 or '72, Mr. F. P. Vergon, the owner of the adjacent lands, thought of the idea of making a fish pond or lake, by building a circular dam at the upper end of the road culvert, letting the ends of the dam rest against the wing walls of the culvert. He accordingly went to work in 1873 and built the first part of the dam. It is a semi-circle twenty-four feet in diameter on the inside. The stone work of the dam is twenty feet high and two and one-half feet thick, with earth filling on the back.

The stone are all limestone, except the top course, which is Berea sandstone. They are laid in courses which are from six to nine inches thick.

In 1876, Mr. Vergon raised the height of the dam seven feet one inch by putting three courses of Berea stone each two feet thick and one course one foot thick on top of the dam, and build-

ing the wing walls of the culvert some ten feet higher, at the same time raising and widening the road bed in proportion.

The only weak points about the structure are the wing walls of the culvert, which are not strong enough to bear the pressure of the ends of the dam, and on the lower side the immense pressure of the earth filling behind them, and notwithstanding tie-rods and braces, will be down soon.

There was considerable leakage the first season, but since then until the summer of 1887, the level of the water has never been more than eighteen or twenty inches below the top of the dam, but the frost has misplaced the upper course of the stone work so that it has leaked more the last two seasons.

The area covered by the lake is some eight or ten acres, and its length about three fourths of a mile in a straight line.

The lake has never paid anything as far as fish are concerned, but has been a paying investment on account of the fine quality and quantity of its ice crops, and the pleasure grounds connected with the upper end of the lake.

The cost of the first part of the dam was about $1200 for stone work, and twenty cents per cubic yard for earth filling; for the other part $—— for stone work and eleven cents for fill.

Country Parks and Cemeteries.

BY JOHN L. CULLEY, C. E.

There is undoubted evidence that ere many decades this will be the wealthiest nation of the earth. Increased wealth with a progressive people means increased refinement. We are just becoming wealthy, and therefore just beginning to indulge in those refinements which riches gratify. The older eastern portion of our country, on account of its wealth, has long since indulged in these refinements.

The beautiful and charming creations of the landscape art are among the highest expressions of refined taste that wealth alone can gratify, and so broad is its philanthrophy that it gives joy to all beholders. Whilst it is true that pretentious landscape treatments require careful study and wealth for their execution, there are many things that come, nearly every day, to the engineer's notice, that could be made interesting and contribute to the sum of human joys and pleasures without increased cost over the homely or ugly way in which they are usually done; there are many simple things, whose knowledge how to do correctly, will contribute to our usefulness and our compensation. Thus every civil engineer should be able to correctly locate a building site, giving it the proper elevation, distance from the street, and to the lawn the curvature and slope to realize the best effect.

There are in every hamlet public grounds for the improvement of which small appropriations are made, which, by the exercise of a little thought and study, may be rendered exceedingly interesting. Upon you, gentlemen, in a large measure, depend their salient characteristics, since their plan and execution are in your charge.

To the country cemetery, from the week of toil and labor, we go on our day of rest and recreation. There we mourn the departed and beautify the last place of mortal rest. There the whole country goes, and every day through the village park we go. These spots so constantly visited should be rendered so

attractive and interesting that to each visit there will still remain the desire to return and explore their hidden treasures. The small appropriations made for their improvement can, and should, go much further in this direction than they generally do. It is to these, our country parks and cemeteries, their conception, plan and execution, that your attention is now particularly called. A modern cemetery having all the characteristics of a park, we will confine ourselves to its discussion, since it will cover both branches of our theme.

There are certain precautions to be observed to secure the best results to a treatment. First, and above all things, is its location. More cemeteries have been spoiled by bad location than from any other cause—giving them surfaces that neither art nor money can redeem. The surface should be naturally adapted to the purposes for which it is to be used. Such careful selection will obviate lavish expenditure of money to render attractive that which is so by nature. The territory should not be so flat as to be taken in at one view, nor so broken as not to work up nicely. A gently rolling surface easily drained, with an occasional ravine and wooded space, is best adapted to this end. These picturesque spots, abounding in natural scenery, found in every section of the country, are the ones to be appropriated, and cost no more than the illy adapted ones.

The soil should also be carefully considered. Stiff, heavy clay soils should be avoided, on account of their retention of moisture and difficulty of thorough drainage, involving unwarranted expenditure of money. Open, porous soils are the best. Besides being self-draining, they are easily handled, thereby materially reducing the cost of their improvement.

Located on a main highway, the grounds should be accessible to all parts of the surrounding country and removed not too far from the center of population.

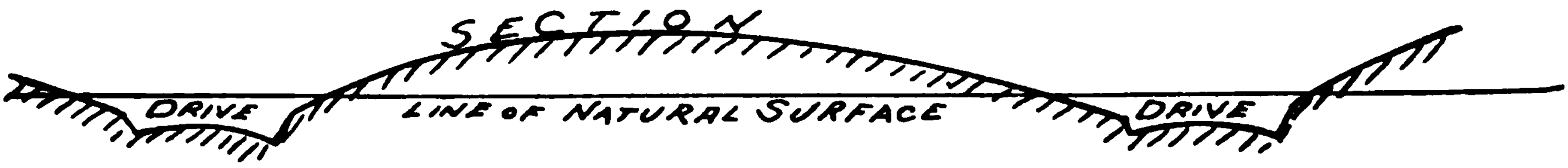
Christen the spot so happily located with a name appropriate to it and its surroundings, whose mention will awaken interest and pleasure in its association. There is a fascination in the names of Spring Grove, Greenwood, Lake View, Chestnut Grove, Lawn Wood, etc., that carry us to the beautiful spots they designate.

The grounds are then surveyed, all interesting objects and

features located and a general plan of the whole is made, providing for future extensions as well as for present needs. To this end drives are established to secure easy grades, light cuttings, graceful alignments and proper sized sections. The entrance should be approached by a broad carriage way. The main drive should be distinguished by greater width than all other drives, and by its directness should at once carry the impression that it extends through the entire grounds, as in fact it should. All other drives may be located at pleasure under certain restrictions. The sections should never be so large as to be inaccessible, nor so small as to tempt people to a shorter drive over them. Sections and lots should be numbered, and the drives known by their vicinity to the sections: the main drive, the east main drive, etc., or by similar designations. All sweet names, as "Butter Cup Avenue," etc., should be avoided, such designations being in bad taste.

Shade trees should be so planted that their regularity or oneness of kind shall not become tiresome. At all times enough of the ground should be in view to interest us, but never enough to satisfy the curiosity. The observer should ever be enticed to discover what lies beyond. Never should the surface be so smooth or the drives so exposed that all can be seen at once; otherwise your creations would not be explored. You may satisfy the observer occasionally with a straight or long sweeping drive or with a broad expansive view, but never his curiosity by showing him the whole at a single view. Let the drives sink from view, or the landscape intercept the desired sight beyond.

This variety should never be unmeaning, destroy the harmony of treatment or lead to confusion. The treatment should always appear natural — never strained or coerced. So refine it with sweeping, flowing avenues, softness of surface and fully developed growths that the sense of the beautiful is ever present. Beauty is not necessarily expensive. Many simple, inexpensive things may be made to contribute to it. Since a level surface always appears flat, the sections should be rounded and full. This is readily done by locating the drives at a much lower grade than the sections; first to secure the material for rounding and filling out the sections on either side of the drive, and second, to render the drives the natural outlet for all drainage. The modest appropriations made



for this class of improvements do not generally warrant the luxury of a system of sewers. The drives therefore should have sufficient grade to discharge all the water conveyed to them. The fact remains, however, that roads, good all the year round, cannot be secured without sub-drainage, which is best done by a pipe drain laid three or four feet deep under each gutter in trenches filled with porous material.

To render their central portion as dry as possible, it is desirable that the drives have considerable crown in cross-section, especially so when first constructed, as the drives have a constant tendency to flatten from use. A light crown will answer for a drive, thoroughly drained and sub-drained. Even then there should be crown enough to quickly convey to the gutters all surface water.

A layer of from four to six inches of good gravel over the entire surface of the drives will materially contribute to their durability. The surface soil should be removed before and replaced after the sections are rounded.

Where the treatment is at all pretentious it is customary to put down the entire drive borders of the sections with selected sod, and to seed the balance of the section. It is of course, much cheaper to seed the entire lawn of the sections.

Maple and elm are the standard trees for parks and cemeteries. They may be placed at regular distances along the drives, and in clusters, or at regular intervals within the sections. The evergreen best serves the latter place, especially so when mixed in with the maples and elms. Whole avenues may be shaded with a single variety of tree, or one side of the drive with a single kind and the other with another, or they may be alternated on each side with several varieties. Young, healthy trees should be planted in good soil in the spring.

An occasional bold feature, as a straight avenue terminating a succession of winding drives, a rubble walk, etc., will enliven the treatment and give it a picturesque effect.

When the grounds are extensive enough to provide for

future years, it is good policy at its inception to improve and utilize the grounds as near the main entrance as possible, as there is a constant tendency to pass them and secure property in the most remote portions. Once thus neglected, they will ever remain unoccupied. Many of the best treatments of the land are cursed with unsalable sections on this account, though they are of the most choice and beautiful within the grounds. Nor should more of the ground be laid out at any time than to provide for actual needs, or to unnecessarily increase the labor and cost of the proper care of the grounds. Moreover, sparsely occupied sections convey the impression that they are neither choice nor desirable. The economics of first cost and the future care of all improvements should be carefully considered. To this end, the roads, drives and avenues, whilst accessible to all portions, should be as limited as possible in numbers and extent. To be inviting, they should ever be clean, well rounded and compact, and therefore never in such quantity as to tempt neglect. Now, in the best grounds, the walks are not worked or graveled, thus diminishing the cost of their maintenance, — they cease to break the sward which should be one continuous lawn throughout each section. Properly considered, the walk is a right of way only of the owner to his property. A decided objection to the old-fashioned rectangular system of laying out grounds, was the enormous amount of labor required to maintain in a respectable condition its numerous walks and drives. Small grounds should have but one entrance ; large ones as few as possible, for besides the cost of their maintenance, they open short ways through them, and lose the opportunities of disclosing the attractions of the grounds. So laid out should the grounds be that people will be compelled to go, as well as attracted, through them. Never more than two entrances should be provided, and those should be at opposite ends of the grounds.

The chief architectural feature of a country cemetery is its public receiving vault, which should be of a pretentious character, of good design, ample capacity, and located within a reasonable distance of the main entrance. There should be a substantial office and tool house at the main entrance, which shall shelter the guests in stormy weather.

The character of a treatment is born with its conception. Upon you, then, will almost entirely depend its beauty, design, care and future management. You should therefore not only devise and execute its plan, provide it with a plat-book containing a general plan of all the grounds and a detailed map of each section, and a journal providing for a full and complete record of every transaction, but also formulate wise rules for its future development. Your selections in this respect should be few and choice. No head or foot stones should exceed a limited height—say fourteen inches. No monument should be erected unless upon a good and sufficient foundation; no heavily-loaded wagons should be allowed within the premises save by permission of the Trustees. Under their direction you will fix the price of the lots by the square foot, calculate the contents and value of each lot, and enter all in the journal record. Said rates to be final, and to cover the cost and future care of the lot. The entire grass plat to be in charge, and to be cut and cleaned at regular intervals without expense to the lot owners. It is therefore important that no fence, railing or lot curb of any kind whatsoever be tolerated. Such provision will prevent any portion of the grounds becoming unsightly from neglect or decay. The authorities should direct what trees, shrubbery or other ornamentation can or can not be allowed upon a lot or section, and designate their location.

To you they will look for these and other useful rules for their guidance.

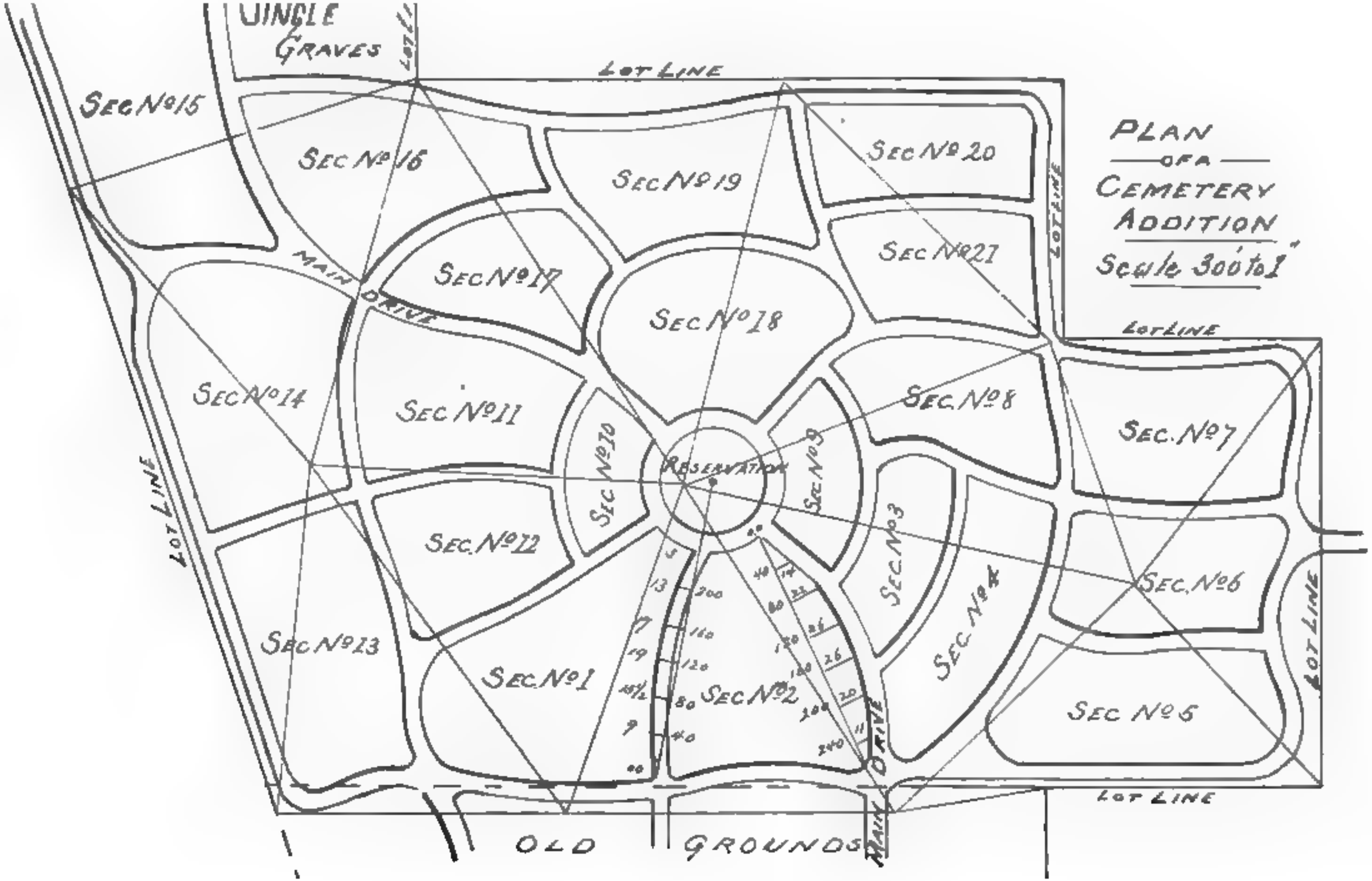
On account of the latitude allowed in modern art, it is obvious that a great variety of beautiful results may be produced on the same ground. It is a fact that though restricted by the principles of the art, no two treatments are laid out exactly alike. The monotony of the old style is not met here. There is an enchantment in the visit to each of these creations in an assurance that it is utterly unlike its kind and filled with new and interesting objects.

In this discussion it is not practicable to introduce elaborate plans. The general plan here shown is a five-acre addition of comparatively level ground to an old geometric cemetery. The circle in the center, reserved for a large public monument, gave a decided character to the cemetery plan; being the central point of attraction, the drives radiated from it. The plans would have been

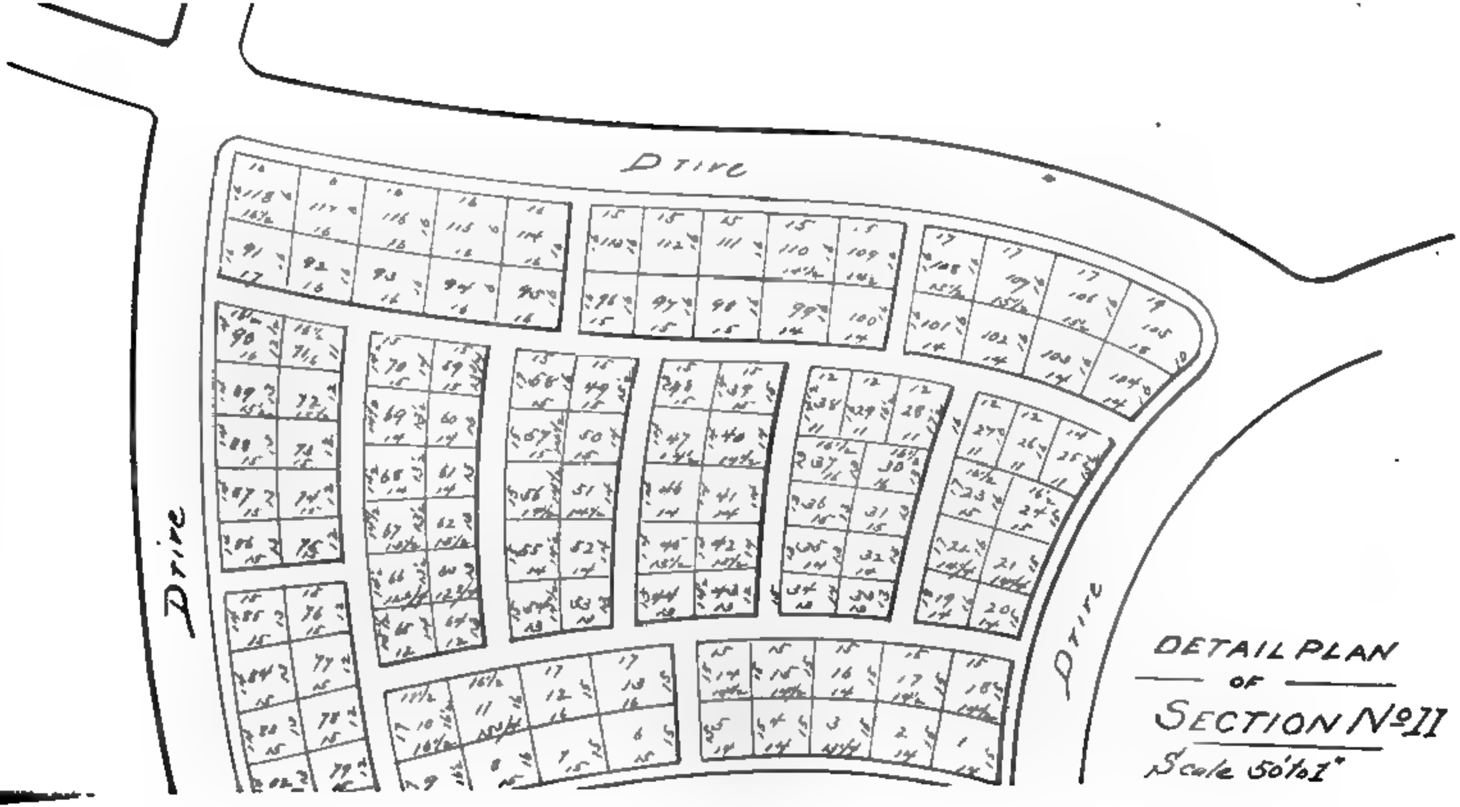
altogether different had this feature been left out. The triangulation shown in this plan was the method here pursued in surveying the grounds. Stakes are set at convenient points and the sides of the triangles measured. This is the quickest known method of measurement of this grade of topography. It is accurate, rapid and reliable; dispenses with the use of the transit, and is very useful in reproducing the plans on the grounds. The method by which the drives are laid out is shown by the base line and ordinates thereto on either side of Section No. 2.

A detail plan of one of the sections is given, showing that though the section itself is quite irregular, the lots closely approximate rectangles, which they should as near as possible. The dimensions are usually restricted to lot lines from ten and twenty-five feet long. The variety in the size of the lots explains the necessity for the valuation of the lots by the square foot. For the convenience of publication, the drawings here shown are greatly reduced from their proper dimensions.

[See drawings on following pages.]



PLAN
—OF A—
CEMETERY
ADDITION
Scale 300' to 1"



DETAIL PLAN
OF
SECTION No. II
Scale 50' to 1"

Mr. Strawn: Mr. President, one of the difficulties that the engineer will run across in selecting a cemetery is to find one that will fulfill anything like the description Mr. Culley has given; that is, that it must not be closer than two hundred yards of any hamlet or dwelling; I know of two or three places now that have hunted the country over for a place to bury their dead and while they have not exactly filed them away in pigeon holes until they could find a place, they have been put to great inconvenience; they have buried in a temporary place until they could get such a place. I heard a gentleman describe how they buried people in New Orleans; he said they did not have cemeteries there like they have in this part of the country; there are no graves dug down below the surface of the earth; the grave is raised up; that, of course, would not be in accord with Mr. Culley's idea of beauty; another thing is to get the proper kind of soil; I remember of hunting for a location for a Catholic cemetery about two years ago, and there were a number of places that seemed to be very nice but unfortunately there was some little hovel or hut within two hundred yards of where you wanted to get the ground, and we had to go some place else, so we were driven to a place about three times as far as was desirable, and then it was not at all desirable, and to put it in proper shape was very difficult. Mr. Culley's paper is worthy of study, and I personally thank him for what he has done for us.

Mr. Culley: In reference to the matter of names I will state that the names given to avenues are apt to be too sweet for any thing; as a rule, cemeteries or parks, particularly cemeteries, have the drives designated by the location of the section, for instance, drive on east side of section two, etc. I think these sweet names are in very bad taste. Mr. Strawn in speaking of the manner of burying the dead of New Orleans reminds me that my attention was called to the manner of burying the dead in the old country, where land is very valuable; a whole family use one grave; when the first interment is made, the casket is buried very deep, say about ten feet, then when the next interment is to take place that casket is placed on top of the last one, etc., and one grave answers for the whole family.

Mr. Bowen: I would like to ask Mr. Strawn what he thinks

of cremation as compared with the common method of disposing of the dead.

Mr. Strawn: I do not like that idea; it always had in my mind a kind of forecast of what might be a hot place, and I never liked the idea of the thing being made hot for me, and for that reason I object to it.

Mr. Bowen: On the ground that your dislike is entirely personal.

Mr. Strawn: Nearly all our dislikes are personal.

Mr. Nicholson: The paper made some allusion to tree-planting in cemeteries; if there are any members present who remember Spring Grove about twenty years ago you will remember that it was very beautiful then, it is still very beautiful, but to my mind not as handsome as many years ago; the cemetery is partly on low ground and partly on hilltops; when the trees were small there were most beautiful views down these glens, but since the trees have grown, it is almost impossible to obtain a view, the trees are now so large that you cannot overlook them. It is the same way in Eden Park; that park is rapidly losing its beauty; the forest tree craze that they have down there has led them to plant the entire park with trees and the consequence is that the beautiful vistas that you have of the Ohio River are entirely cut off.

The Chair: Mr. Culley speaks of one custom in the old country, there is another custom prevalent in one of the old country cities, I am informed, which is, that a permit to bury in the public cemetery is simply a lease for thirty years of the land; at the end of the thirty years the body is disposed of and they have a right to use the ground for the next one.

Mr. Nicholson: In New Orleans it is necessary to bury above ground; almost the entire city is only a foot or two above sea level; it is only necessary to dig a foot, or at the utmost, three feet, to reach a well or cistern, and cellars are unknown; the burials are really in tombs, a new cemetery was started some ten or fifteen years ago, which has grown to be a very handsome cemetery on what is called Mittery Ridge; it is half way between the Mississippi River and Lake Pontchartrain; the distance is four miles across, and between them is what is called Mittery Ridge; the greatest height is four feet above Lake Pontchartrain. They

manage to have burials in that cemetery in the ground instead of in the tombs; they have laid that out in modern system as described by the gentleman in his paper.

Mr. Culley: In a paper of this kind it is impossible to cover the whole subject; the question arises as to the location of the potter's field; in some places they have been placed in most outlandish locations, but in late years a great deal of attention has been paid to that, and choice portions of the cemetery given to this purpose; in many of our cemeteries, the choicest part of the cemetery has been given to this purpose; that is the case with Woodlawn Cemetery.

Mr. Brown: What do you think of the growth of the process of cremation?

Mr. Culley: I am decidedly in favor of it, but while we have cemeteries we must provide for them.

Mr. Davis: I would like to ask Mr. Culley whether he has had any experience in sodding, in getting the grass to grow on the lawns; whether he practices sodding, or what kind of grass he uses? (Mr. Culley here explained, by diagram, his method of sodding lots.)

Mr. Culley: The best sod for sodding is clay sod. This fall I was in Erie, and they told me that the best sod they got was a very sandy sod; the best in our section is clay sod.

Mr. Harvey: The question that interested me considerably in the construction of cemeteries, was how to secure uniformity in the construction of these slopes; and as this figure has not been discussed, I would like to ask a few questions in regard to these slopes. (Mr. Culley here explained by diagram on the board.)

Mr. Culley: The slopes would depend entirely on the soil; if it is a good, strong soil, one and a half to one would be ample; of course, if it was sandy, it would have to be more.

Mr. Strawn: In locating your curbing and drives, I would like to ask whether you locate all of these from your primary triangulations?

Mr. Culley: Yes sir.

Water Supply—Difficulties.

BY H. F. DUNHAM.

When invited by your honored President to bring a paper to this meeting of the Ohio Society, I think I should have declined had it not been for the opportunity an acceptance offered to express to you all my deep appreciation of the honor shown me. At least, if I am successful in such expression, the paper will be in one particular satisfactory to me, and by making it very brief —for I know the value of your time at these meetings—I may hope to prevent it from greatly displeasing you.

I was requested to touch in this paper, upon some of those difficulties, in the supply of water to cities and towns, which are increased by an increase of population, and by that natural tendency in the population, whether it is dense or not, to leave undone that about which it ought to be particularly active.

I am aware that upon no other topic is there quite so much risk to the reputation of a writer, for the criticism first made may imply his desire to create a sensation, and the one last made, his anxiety to profit by the sensation he has created. There is, however, in a Society like this, common ground, and we are all glad of it, upon which a man may firmly stand. When in his every day practice he encounters obstacles that he is powerless to remove, and against which his insight and skill is insufficient to enable him to make much headway, then he should deem it a privilege to state his troubles plainly and fairly before such a body and beg for sympathy, counsel and assistance.

In a spirit quite like this I venture to refer to certain abuses of vested rights, by organizations second in importance to none in the country—by the railway companies of the United States. I know something of the pride we all feel in our railway passenger service—the finest in the world—trains that are palaces, speed that is wonderful, approaching that of the swiftest bird, but gentlemen, there never has been from the earliest age of reptiles

to the present time, a slimy monster nor a half-developed, loose-jointed creature that moved upon a dark continent or a guano-covered island with such freedom and *such filth* as that which marks the movements of our idolized passenger trains — limited and unlimited.

Over a large portion of our country, cities and towns are now, and must continue to be, supplied with water from springs, from small streams, from drainage areas where artificial structures may increase a limited supply. The places best adapted to furnish water under these conditions are well known to the engineer. The thinly settled wooded districts, on each side of some ravine, the springs that flow uninterruptedly just where the base of some high hill rises from the plain; the little brook that finds its way over the long distance that separates it from any larger or better body of water; all these are to be kept in mind and should, as occasion demands, be utilized. Under the laws in many of our States the inhabitants of a district tributary to such a source of supply have no right to create or maintain a nuisance. The rights of the larger number must be regarded. If a case of fever occurs it is generally known and may be isolated. In more than one of our States active commissions are giving close attention to these sanitary questions, and good results are certain to follow.

But now above all other places, the bank of the tumbling brook, the steep side of the ravine, the terrace upon the hill just above where the springs flow, these are most likely to be marked off by two steel rails, and wherever the rails lead the filth distribution follows, both ways, in season and out of season, in station and out of station, naturalized and unnaturalized. And when the engineer, familiar with the history of Plymouth, Pennsylvania, or with that of other cities, or with the more discouraging fact that certain diseases come from we do not yet know where, takes a portion of a railway embankment into the middle or into any part of such limited water shed, his method is neither a good nor a justifiable method. But what else may he do? The question is not an imaginary one.

If permitted to be facetious one might hint at the explanation of the size of the earth — somewhere advanced, that is due to the fall of meteors. But no similar thec y will apply to railway em-

bankments; besides the natural denuding agencies other forces are at work. Following every train there is a rush of air which lifts autumn leaves and fine sand, and whatever else may be of medium density, into the cars, and the traveler, scarcely able to breathe, it may be, is certainly able to reflect that the tie-dried dust by which he is surrounded, was but recently surrounded by some fellow passenger.

But I have no desire to divert attention from the pressing facts and the main question. What shall the engineer I have referred to do? And as the country becomes more densely settled and the passenger traffic increases, the question asked becomes the more vital.

It is easier to say what others should do. These roads have the right of "Eminent Domain" it is true, but they do not have even that right for manurial purposes. Through State legislation if necessary, and by the aid of earth closets or other suitable devices, every train should be made to manifest the common hygienic sense that was formerly noted in the behavior of the common hygienic wild cat, now railway driven from his old haunts disgusted.

Concerted action by engineers would be helpful. Only a few years ago that respected body, the American Society, succeeded in regulating the movements of railway trains in the country to our great advantage. Without legislation or delay, it should be possible to regulate the movements of the chronically disordered portion of those trains.

DISCUSSION.

Mr. Judson: Mr. President, I would like to say just a word on this subject. It is a very difficult matter to get pure water, and we should throw all the safeguards around it that we can; and particularly is that the case where it is taken from a natural water shed, as this paper contemplates. But, on the other hand, it seems to me that, while Mr. Dunham has set forth something that may be a danger, and, while I suppose the pollution of water in this way might be possible but I can hardly go as far as Mr. Dunham has gone, in saying that there is any real danger from the

depositing of this material on the road bed itself. It is true, we do protect these water sheds by certain regulations; for instance, a village on that water shed shall not discharge its sewage into running water which is used for drinking purposes. This is perfectly proper, of course; but, on the other hand, we do not attempt to prevent a farmer from distributing manure over his land, although it may be the next rain will wash a portion of that into the water; in other words, it seems to me the same rule would prevent the farmer from improving his land. It seems to me there is a limit beyond which we cannot go. The pollution to which he refers of the water at Plymouth, Pennsylvania, if I remember correctly, was actually done by one man who lived near the source of the water supply, up near the top of the mountain. The impurity was carried down, and the people drinking the water were taken down with typhoid fever. Of course, something of that kind might happen from a train passing over a stream, but, as I said, I don't think that a deposit of this material upon the road-bed would create any particular danger. Now, the people along the Ohio River and other streams are taking their water supply directly from these rivers into which is discharged the sewage of towns and cities higher up the streams. Now, that looks dangerous, but in practice we find that these people have done that thing right along and without any harm so far as we have seen. Of course, in certain cases it may have; that is a case where there is no chance for the sewage to be exposed to the air.

Mr. Strawn: In other words, you shall not pollute the stream until it gets below where we take our water from. It was my intention to present something upon this subject at this meeting, but circumstances which surrounded me, and which I shall not now speak of, prevented me entirely from doing anything in that line. All those of you who are familiar with the great river know of the extent of the pollution of its waters. The refuse from Pittsburgh and Allegheny come right down to Rochester and Beaver and all those towns along there, and they guide their sewage into the river, and it comes on down to Liverpool, and they take their water right from the river without filtering it, and discharge their sewage into the river. About three miles below is Wellsville, and

it takes its water and discharges its sewage. Right below is Steubenville, and when it gets to Cincinnati you can have some idea what the quality of the water is at certain stages and certain seasons. There should be something done to protect our streams that are made not only our carriers of steamboats and freight, but carriers of our sewage and suppliers of our drinking water, and water for domestic use in general. That is the kind of soup that is dished up, and when I have been along the Ohio River the time of freshets, I have seen the carcasses of half-rotten horses and cattle floating down, and knowing that the people right along there were drinking that kind of soup, ox-tail soup I suppose you would call it, and seeing the masses of filth crowded and dumped right over the banks from water closets, and filth put into old barrels and dumped where the little freshet coming down would carry it away; it is an outrage on humanity, and I do hope the inventive genius of a Yankee will be brought to bear upon the great problem and solve it, that we may not have this, which seems to be the most indecent thing in modern civilization. We have our beautiful carriages and fine horses and beautiful harness, and keep drivers and all that, and yet we are drinking this mixture as our daily beverage. It is an outrage; I can hardly think of anything so indecent as to drink Ohio River water.

There is no knowing what a person will drink or what he does not drink unless he can see the source from which it comes. We should certainly try to devise some means for keeping pure the streams which supply our drinking water and preserve it from this terrible pollution that is becoming worse and worse every year. The Ohio River is perhaps one of the very worst on this continent, and perhaps has more filth than any other stream that flows on the surface of this continent anywhere. I speak of this because I have lived close by the Ohio River and been along it so often. I have probably become kind of soured against that kind of beverage.

Mr. Bowen: There is no question that the subject under consideration is one of considerable importance. The habit of throwing offall into the creeks and streams and rivers, and this way of polluting the water courses is entirely too general, and the sooner

it can be remedied the better. Every town with proper sanitary arrangements must have sewage, and that sewage must go somewhere. Unless it is discharged into the river, they must dispose of it by cremation or some other plan. That is probably the cleanest way of getting rid of it. There have not many of our towns in this country come to that yet; possibly in the future, more of them will adopt that plan; some, I believe, already have. There is this about the river business: to take the amount of sewerage that is deposited in all the river tributaries of the Ohio and the towns and cities on the Ohio, and then try to determine what that mass would be when it got to New Orleans, it would seem that it would be simply a river of excreta. But, when we get to New Orleans, or any of those lower cities, we do not find that condition of things. I understand that the character of the water is bad enough, but not as bad as our computation would make it. I don't suppose the condition of things will ever come, in this country, when every town and city and village will have its crematory to dispose of its sewerage and discharge nothing into its streams. It may possibly be in the far future, but so remote that I do not suppose any of us or any of our children will see the time. Now, if I understand Mr. Dunham's paper right, I am in doubt as to how to consider it. I am inclined to think that the whole thing was written in a facetious moment about Christmas time.

Mr. Judson: There is just one word more I would like to say, and that is, that it seems to me, as Mr. Bowen has just said, that there is danger in this matter of putting too fine a construction upon it. If we stop a moment and think what it is in sewerage matter that makes it dangerous, I think we will say that this danger that Mr. Dunham pictures, is really imaginary. There is certainly a principal matter which we will call the nitrogen or active matter, now in that form it is dangerous, but when changed into the nitrates it becomes harmless, and after that, as I understand, the taking of it into the system is not dangerous. If we stop and think a moment, the fertilizers of the soil are changed and taken into the system again. Now, as I understand it, the real dangerous part that he pictures, for instance, in the Plymouth case, that

the danger there are the germs of disease that are contained in the stream, called microbes, or something of that sort, and that while still alive, it is taken into the human system. That is the theory, at least. Now, if that material could be exposed long enough for these to decay, which would be only a short time, if exposed in the air, the greater part of the danger has passed away.

The Chair: Right on that point I remember Mr. Shreve, whom we know and respect, tells me something of the situation in Mexico, where he now is; and he tells me that they have a state of things there which in this moist climate would make the death rate very great. He says there is no sewerage there at all, and very little attention is paid to having water closets or any thing of that kind. He says the air is so dry that there is scarcely any offensive odor, and the dead animals there give out but very little bad smells; that, although the city of Mexico has a very high death rate, it cannot help it even then, there is so much filth there. He thinks with a moist atmosphere it would be uninhabitable.

Mr. Brown: In regard to one or two statements made about the effect of the sewage discharged into the Ohio River, upon the health, for instance, of Cincinnati, I think it was this summer a year ago, if I remember rightly, that Cincinnati had almost an epidemic of typhoid fever, which was claimed to be the result of impure drinking water. If I live as long as I ought to, I expect to see the majority, if not all the towns in Ohio, adopt some other method of disposing of their sewage, other than turning it into the streams.

In the New England States, Massachusetts, for instance, there are a large number of towns in the eastern part of the State that do not dare to turn their sewage into the streams, because the water is used for drinking purposes lower down. Whether such laws should be passed by this State or the United States is a question. In regard to the Ohio River, for instance, what control would the Legislature of Ohio have over the Ohio River. It does not belong to us. It belongs to Virginia and Kentucky. I just happened to think of it a moment ago, and the Virginians

and Kentuckians could turn all the sewage they wanted to into it, and we couldn't prevent them.

Mr. Arnett: Gentlemen, I ask for information; are the microbes of disease, animal or vegetable?

Mr. Judson: Well, I am not very well up in the science of biology, and so I couldn't very well answer the gentleman's question, but I suppose they are animal life.

Prof. Orton: Vegetable some of them are, I think. In connection with this discussion, I presume the case of Bellaire will come to the minds of some of you. The water supply of Bellaire was polluted by the discharge of the Wheeling sewage, and the pestilence has broken out there in two successive seasons. I thought likely Mr. Strawn would have reference to that in the remarks he made. I presume you are more familiar with the case of Bellaire than I am, but the Board of Health examined the matter, and had an analysis of the water. The people that got water from wells in that case were protected. Prof. Brown has spoken of the case of Cincinnati. I think in both these cases that the sewage came from some place closer at hand than from these distant cities, but in reference to the pollution that might come from railroad trains, I do not know of a better way to dispose of excreted matter than to leave it on the soil, but when it comes to the matter of pollution of our rivers by the discharge of sewage, that is a different question. While there is a correction going on there in the process of nature, still where a large amount of this sewage is aggregated, no man knows how far these germs may be carried. I share in the hope which my friend, Prof. Brown, expresses, that before another generation goes by, that towns and cities will be forced to dispose of their sewage in some other way, and not leave it to the little rivers. Cities upon the great rivers can trust to the great rivers. The Mississippi water is fair at New Orleans, but that does not help us on the smaller streams. It doesn't help us in the city of Columbus. We have a great sewer now being constructed, and while we carry below the city, I think it a short-lived policy, and I think we will be obliged to correct it before another generation goes by. We have the use of the soil for the correction. If this infiltration is carried on in the proper way the germs are destroyed there.

Description of a Sewer.

BY H. L. WEBER.

It was about the year 1838 when Abraham Hahn, then a resident of the village of Bucyrus, conceived the idea to dig a mill race, from what was then a swamp, on lands owned by Col. Zalmon Rowse, which were situated on the line of the dividing ridge, from which the water shed to the Great Lakes and the Gulf of Mexico. The idea, when carried into effect, did not prove to be a financial success to Hahn, so far as mill race was concerned, but on August 14th, 1838, Hahn's endeavors were rewarded by the finding of "the mastodon skeleton," which brought him a snug sum of money that relieved him financially, and aided him materially in banishing the mill race idea from his brain. By the construction of this race, the waters that formerly went to the Gulf via the "Scioto," were turned into the new channel, and conveyed through the then a village, now the city of Bucyrus, via the Sandusky, to the lakes. As the village began to expand, the mill race stood in the road of progress, and it was shifted and turned to suit the desires of the property owners, until at the present day, scarcely a trace of the old mill race is visible. But the diverted, crooked, sluggish stream, which found its way through our city, was ever an eye sore, and the source of much complaint, and, at whose door, suffering humanity was ever willing to unload a good share of its sorrow. Then there were many who would testify against it, charging it with robbing them of their dear one, and their home of its life and sunshine, until "forbearance ceased to be a virtue" Something must be done, was apparent; the iron was getting hot, and it was high time somebody must wield the blow. Who should it be? As the old saying is: "What is everybody's business is nobody's business,' seemed to fit this case perfectly. Somebody must strike, to defeat old grim death, who kept a constant knocking at the doors, and who was often admitted, one, two, and sometimes the third time, in the same family, to drag away his innocent victims. I must acknowledge, our citizens were careless, or rather afraid, to move for fear the

work could not be accomplished, for the simple reason: the lack of means, and often have I heard the people express themselves, when the subject was approached, that it would cost $100,000 to sewer this "stream."

It was in the fall of 1886 that I conceived the idea that the old, shifted, turned, and sluggish stream, could be, ought to be, and should be sewered, if it was within me to devise and carry into effect, some plan, by which to do it, and to make a grand sewer system of the stream and its tributaries. Being the city engineer and county surveyor, I began looking up the sewer laws. In them, I found many stumbling blocks. Then I tackled the ditch laws. In them, I found more consolation, and in the treasury of Crawford County, more money than in the city treasury, and as the saying is: "money makes the mare go," I did not know, but that with the aid of the ditch law, and a good deal of vim, money would be the one essential thing to make the sewer go, which proved correct. The first thing to be done, was to interest some of the enterprising citizens and the City Council. So I made a preliminary survey, and approximate estimates, which, for cheapness, surprised all. And instead of costing $100,000, I clearly showed them it would not cost $20,000. At the next meeting of the Council, after my preliminary survey, a resolution was presented, and passed, describing the line of the improvement, and what was desired, authorizing the Mayor to present the petition for the location and construction of The Bucyrus Sewer (Ditch), which I will endeavor to describe. The petition was presented, and its prayer granted by the Commissioners. I was ordered to make the survey, plans, specifications, and file my report. At this T. P. I had begun to realize what had been done, and that I had no small fish to fry. My first work was to make a careful examination of all the area to be drained, ascertaining, as *near as possible*, the exact number of acres drained by each branch, where it intersected the main, its rate of fall per 100 feet, and the greatest volume of sewage or storm water it would ever be likely to contribute.

After a heavy rain, I consulted my storm gauge, to see the amount of water fall, and made gaugings of the main stream

below each tributary, by cross sectioning and testing its velocity in every manner my brain could devise, until I had sufficient data upon which to base my calculations. After using up about all the figures there was, I felt very thankful I still had enough left (figures) to express the result, which was as follows: The main from station "0" (its head into which the storm waters off 465 acres drain) to station 17 = 1700 feet, an egg shape brick arch (horizontal dia. 3' 5" by vertical diameter 4' 3½"). From 17 to 36, size 3' 11" x 4' 10"; from 36 to 46, size 4' 2" x 5' 2"; from 46 to 50, size 5 ft. "circle;" from 50 to 62 an open ditch to river. The reason we did not go to the river with the arch was: First, we struck a flat territory and could not bury the arch. Second, had no ground to make the fill. Third, didn't have the means to do it with. Then, beside, it was a *county ditch, don't you see*, a little piece of ditch above, a little piece below, a sewer sandwiched in between, to make the whole thing go. (Will tell you all about the mustard that went with sandwich by and by.)

In the near future, we will run an incercepting sewer to the river, to provide for the dry season or minimum flow.

This sewer was to have a mean velocity of 6.7 feet per second when completed, and by test made after completion, by placing blocks of pine 30" long, 8" x 8" square in the sewer at the head, it traveled through a distance of 5000 feet in eleven minutes, or = 7.6 feet per minute, but this being the surface velocity, it is swifter than the mean velocity. So calculations from tests made gives us surface velocity = 7.6 feet per second. Invert velocity 6.08 feet, and mean velocity 6.75 feet per second.

The sewer when tests were made, was 24 inches deep at station 0, 22 inches deep at "9," and 22 inches at "31," and 22" at 10 feet from outlet, and 20 inches at outlet; fall 1 foot in 217½. So through the first 1700 feet. Size, 3' 5" x 4' 3½" = 11.5' area. Average fall 1' in 217.5'. Velocity = 6.7' per second. Discharge = 77.05 cubic feet per second, or the sewer is calculated to drain the 465 acres with a rain of 1 inch in every 6 hours. Calculating it all to reach the sewer in the 6 hours, but as only about ⅓ or ½ will reach the sewer in that time, it is evident it will dispose of 2 to 3 inches of rainfall in the 6 hours.

LOCATION.

In locating, a line was run parallel, and from 4 to 7 feet to the right or left of the center line, for both main and branches as the surroundings would permit. Intersection of all street, lot, and alley lines were carefully noted (from which to relocate the house and other connections). Every connection was located and noted by an assistant as the work progressed in reference to the survey station. As, for instance, a house connection was 12 feet below station 9 (all whole station being 100 feet), the assistant would note as follows: At 9.12 — 6-inch house connections; east side; John Smith residence, etc. All curves had a radius of 63.7 feet (or were 90° curves). Stakes on curves were set every 10 feet, except at P. C's and P. T's, and on tangents, every 25′ or 50′, as the necessity of the case required. At all curves the fall wasincreased. All survey stations were used as level hubs, the invert hubs being set from them. The contractor was provided with a board, the inside cut to correspond to the arc of the inside of the curve, and the outside to the arc of the outside of the curve. This board was used by the workmen when excavating in curves. On tangent they used a line. They also had a form made the size of the excavation to be made, and, as the work was in, from 4 to 6 feet of blue clay, devoid of stone and sand, one could imagine how perfect skilled workmen could dig a ditch. It was so perfect that it was almost impossible to detect any imperfections with the naked eye. Upon the bottom, the invert block was placed, and the brick work begun and carried up to the springing line by one set of workmen, the brick being laid in mortar, made of one part best Louisville cement, and two parts best sharp sand. All joints slipped and struck.

There were manholes built at each side of the street and in the center of all alleys, provided with ventilating covers, galvanized steps, etc. These manholes were also used for inlets for storm water and ventilating shafts. The depth of the bottom of the sewer below grade at each street crossing is 12.5′.

COST.

SECTION.	FROM	TO	NO. FEET.	YARDS.	BRICK.	MANHOLE COVER.	F. INVERTS.	PER MASONRY.	PRICE PER LINEAL FOOT,		
Section 1	50	62	1200	870	12000				23½c	282	00
Open	ditch.			Some	paving.	Average	depth, 4 feet.	S. S. 1¾	to 1	Base 2	
"2"	25	50	2500	5060	469,100	11	2500′	7 = 25c. $	3.43⅓	$8,633	33
400	feet,	5	foot circle	and 1000	feet.	4′ 2″		x 5′ 2″		Egg sha	pe.
1100	....	3′	11″ x 4′ 10″	egg shape							
3	0	25	2500	3685	397,410	12	2500′		2.80	$6,983	34
1700	feet.		3′ 5″ by	4′.3	⅓″	Egg shape and		800 3′	11″ x	4′ 10″	
4	0	1.22	122	200	26,420			13	$4.63	$565	00
3′ 11″ x	4′ 10″		At "0"	and 3′ 5″	x 4′ 3⅓″,	at 1+22					
			Total	cost of	main	....	....	....	.....	$16,863.67	

thought I should put in 24, simply because main and other streets had 24-inch and 30-inch sewers. Not that those streets required that size, for I drain more territory with Poplar street 12-inch sewer than is drained by Sandusky avenue 3-foot and Mansfield street 2.5 foot brick arches. I would ask how is that for building a sewer out of proportion? But, of course, they kicked simply because that was a privilege they had. Then they kicked because I did not put in traps. Here was where the war began, and I suppose there has been enough written and printed in our local papers to fill a good size book in the past year. We only had the war on one street; that was Rensselear. At the head of the street is located a creamery, which, before the sewer was constructed, was compelled by the council to cart its offall to the country; but as soon as the sewer was built within their reach they made connection, and fired the stuff into the sewer, and in less than a week I got h—l, and the citizens along the street the stench. It was simply horrible. Limburger cheese was Hoyt's German cologne as compared with the stench that came up through those inlets. They wanted me to explain. I did. I put the shoe on the foot it belonged, and that made several of the citizens mad, who owned stock in the creamery and lived on the street near the openings. They were going to have them trapped, and they did. Then I was downed. A Board of Health was created. I filed complaint, charging the creamery with committing a nuisance, had the case investigated, and proved my points. Then I wrote an article, claiming that if the creamery was permitted to use the sewer as they were using it, they would stop up the sewer to the main, as well as the main. At this I got the laugh on all sides. But behold, there was a wise looking set of men, when one fine morning in September, a man by the name of Myers threatened to sue the city for nuisance, committed by the creamery, in flooding his cellar with rotten milk. The wise men, the Board of Health and City Council Sanitary Committee, went to investigate, and what did they find? Why, the creamery drain stopped up, 4-inch pipe filled full of grease and buttermilk, and it oozing out through the joints and finding its way along an old abandoned drain to the said Myers' cellar. Then their tune was turned, and

they came to me to see what should be done. When I told them they left, thinking my plan would be too hard on the ones that had caused us all so much trouble. With the exception of this street, or branch of the system, we have had no necessity to put in any traps, and if this branch was furnished with a flush tank, and each branch sewer entering it, provided with water enough to deliver its goods, the main would take care of its self. But when you undertake to cram all the filth, slop and sewage into your sewers without providing any water, the only means of navigation, what more can you expect than it will cry forth with a very *strong voice*: water! water! and I say, give it water and air every time. Provide all our sewers with flush tanks, with automatic or other valves. Go first to the head, "the house" drain; put in your tank there; that is the proper place; have each one store his waste water, and use it to flush the house drain, or, in other words, use your sewage to flush your sewer; don't let it dribble away all day long without doing any good Keep a constant lookout that your house drain is in good working order and well ventilated, and you have done the duty you owe yourself and family; and the main sewer will take care of itself, and should it fail to do so, it will sound the alarm; but I say don't trap it, and deprive it of its only means of warning.

Latham says a sewer with ventilation is far more dangerous than a steam boiler without a safety valve. Who are there among all his brethren here that will go before the people and warn them of their dangers, or sanction what he says.

I would like to hear other surveyors of the State. I have thought a great deal on this subject and written a great deal on this subject, and if I am on the right line, I would like to hear them say so.

DISCUSSION.

Mr. Judson: What material did you use for invert blocks?

Mr. Weber: They are made out of fire clay.

Mr. Judson. Why did you give it such a fall or velocity?

Mr. Weber: Because I wanted to get on the safe side, that is the first sewer I ever built of that size, we went right through the main part of the town, under houses and barns and hog pens, and

other things of that kind. You see it was just full of curves, and there is one reverse curve in the sewer; and on each curve I increased the fall a little so as to maintain the same velocity as nearly as possible all the way through, so as not to have any deposit any where.

Mr. Davisson: How much did you increase the fall around the curves?

Mr. Weber: About 1.100 of a foot in 10 feet. I set the stakes at every 10 feet except on P. C. and P. T. Now, if it had four stations, I would increase it about 5.100 of a foot around that curve; then I carried the same grade right through on a tangent.

A member: What was the radius of curvature?

Mr. Weber: 63.7 feet. It had a central angle of 90°.

Mr. Bowen: I would like to ask Mr. Weber if he observes where the greatest scour was? Whether, it was in passing around these curves?

Mr. Weber: My observation is that the greatest scour is on the inside of the curve. I have been looking up this thing of ventilation and circulation of a sewer; there are nine times out of ten that the circulation in that sewer is down stream. I would like to hear why that is. You would naturally suppose it would be up.

Mr. Bowen: Theoretically speaking, isn't the scour on the outside; but practically speaking, it is on the inside of this sewer?

Mr. Weber: I believe the greatest scour is on the inside of this sewer.

Mr. Brown: The place where the greatest scour is depends upon two things: Upon the velocity of the current and the radius of curvature. We have the same thing in railway curves. Both the outside and the inside rails wear. It depends upon the speed of the train and the radius of curvature. Take a low velocity and it will wear on the inside, but take a high velocity and it comes on the outside.

Mr. Weber: I never was in there when there was much water.

Mr. Davisson: The gentleman speaks about the circulation of air being always down stream. I would like to ask when he was in there, whether he could observe any difference in the tempera-

ture; whether it was warmer inside than it was outside of the sewer?

Mr. Weber: No, I think it was colder in the sewer than outside.

Mr. Davisson: Then that would naturally make the draught, because the cold air in the sewer would naturally press against the hot air outside, and cause the draught down the sewer.

Mr. Weber: We had some parties who claimed that the stench out of this sewer came up through the branches; there was no stench on any branch but one, and they claimed it came from the main sewer and came up through; but I took them down and showed that the current was down the stream, and that it couldn't come up, they then put in a trap and it was worse than ever. I don't believe there are five house drains built properly in our town. I claim these matters ought to be in the hands of the engineer; he certainly knows more about it than the people. We had built a new gas works up there, and they were using crude petroleum and naptha, and one day the pipe burst when they were unloading petroleum, and it got into the sewer, and the people had to hoist the windows and open the doors. It came in through the traps. I had to locate manholes there when it was five degrees below zero. Every thing in the city, in the stores, smelled of the crude petroleum. You couldn't buy a coat without it stinking with that petroleum. I would like to ask what is the proper mode of ventilating in cities, where do you ventilate and how?

Mr. Judson: At our place we ventilate with manholes in the center of the street. Our blocks are about 500 feet long, and we place a manhole at each street intersection, and where the block is very much longer, we put one in between. These manholes are simply iron castings, and are set down below the ground, just coming up even with the surface.

Mote Ditch.

BY F. M. DAVISSON.

The mote ditch is located in the southeast part of Darke county, Ohio, arising in Twin township and flows north and eastward across Monroe township, terminating at the east line of the county, on the Miami county line. Here with its many lateral ditches forms a part of Ludlo Creek, the main line of the ditch being between seven and eight miles in length. This ditch starts at the junction of two township ditches, which drain about 1000 acres of land.

The entire system was dug and cleaned out at various times, under the supervision of the Township Trustees; but, owing to the fact that it never gave satisfaction under their superintendence, as they employed no one to level it, but ordered the ditch cut a required depth at various points without connected levels, not considering whether such work would make a good or bad ditch.

The land at the head of the ditch is so very level that it is difficult to tell by the eye which way the water does run; and to more fully settle questions concerning the ditch, and also as a means of last resort, to make all parties interested in the full length of the ditch become co-laborers, and to get it out of the hands of the Township Trustees, sought relief in the fall of 1883, by petitioning the County Commissioners for a relocation of said ditch. The Commissioners examined the line and decided to grant the prayers of the petition, and on the 26th day of October, 1883, Elliotte Miller was appointed engineer to make the survey and estimates for the same; also, requiring him to give bond for the proper performance of his duties according to law. Elliotte Miller was elected the same fall as County Surveyor of Darke county, Ohio, and gave his official bond December 2d following, and was reappointed as engineer of the ditch during the year 1884, with the same bondsmen, both under his official capacity and as engineer of the ditch, which has laid the foundation for the troubles that followed.

The work of construction of this ditch proceeded during the

latter part of the year of 1884, and summer of 1885, and two of these sections not having *any* thing done on them were relet, when the new contractors were to complete the same.

Waiting a good length of time and no work being done, the parties along that part of the ditch became dissatisfied with the proceedings which followed the reletting, and investigating the subject, found that the contractors had been paid by the engineer's certificate, and the money which they had paid for the construction of the ditch had been wasted.

We give you, in brief, what one of the land-owners said: "When the day for the reletting was advertised, several of the interested parties went to see if we could buy those sections, but we could neither get an opportunity to bid on *this* work, nor could we find out when, where, or how it had been sold. So we concluded that something 'was rotten in Denmark.' Now, shortly after this sale two men came along the ditch, began work casting earth out with spades for something near two hours, leaving their tools in the ditch where they had worked, and that was the last we saw of them, their spades remaining where they had left them until the handles were near rotted off."

On investigation, they found the money had been drawn for the completion of the ditch.

Now, the owners of the land at the head of the ditch filed a petition in the Common Pleas Court of said county, on the 16th day of December, 1885 bringing suit against the engineer and his bondsmen for damages, to the amount that the contractors had failed to complete the first eight sections at the head of the ditch; also damage to crops by its not being completed.

The first hearing was on demur, June 8, 1886, which was overruled, when a partial hearing was had November 12, 1886, when the case was continued.

On January 22, 1887, the bondsmen filed a motion to make the contractors parties to the suit, but this was overruled by the Court.

February 4, 1887, a motion was filed to appoint a committee to examine the ditch, and report its completion according to the specifications for the same. The committee consisted of Justin

M. DeFord, County Surveyor of Mercer county, Timothy O'Conner, a practical ditcher, and myself.

We proceeded in March, 1887, to make the survey, and take the levels on the line of the ditch, using the benches marked by Elliotte Miller, and to make the cuts below the benches found correspond with those of Miller's, which gave us his grade for the bottom of the ditch. You may imagine our surprise when we had the work completed on the first eight sections, finding yet to be excavated 18,178.65 cubic yards, besides 827.53 cubic yards that the ditch had filled since it was reported completed, making a total of 19,006.18 cubic yards to be excavated, when Miller had reported but 12,270.5 cubic yards to be taken out in the first place, which certainly shows a very grave error.

Our work was performed with great care, and in accordance with what Miller's work indicated on its face. By using Miller's cuts, as shown on his profile, for a check on his work, where he marked new cuts, our estimates agreed closely with his; but in the old ditch, our estimates exceeded his greatly.

While we considered that Miller could not be held responsible for a greater amount than he reported, yet we thought it advisable to speak to the attorneys on both sides of the case before submitting our report, and they preferred us to investigate the matter farther, which gave rise to four other reports.

In our second report we assumed that the level pegs driven by Miller were of the same elevation as those driven by us; and estimated a ditch with the same capacity as shown by him, and not paying any attention to the grade of the ditch, letting that take care of itself, as we knew the ditch would not be cut by it, the object being to obtain a result with his figures, which gave 5,856.23 cubic yards to be excavated, besides what the ditch had filled since being cut.

The third report was quite similar to the second, and showed that there was yet to be taken out 5,734.32 cubic yards.

The fourth report was made by Mr. DeFord, on the hypothesis that the earth cast from the ditch had raised the banks slightly, and that Miller's cut averaged 0.9 of a foot less than ours had, in our first report, as it made a good agreement in the level parts of

the ditch, preserving the grade reported by him, which showed that there was some foundation for its assumption, and the amount of earth to be taken out did not vary far from 6000 cubic yards. (The exact figures are not by me.)

The actual difference in the mean cuts of the ditch, as reported by us and those reported by Miller, was 1.12 feet. This looks unreasonable, especially when the difference of levels taken by Miller, and those taken by us showed only a difference on the benches of about 0 2 of a foot in a distance of 20,000 feet. So in the fifth report; we lessened our cuts 1.10 feet, and made the calculations by sections instead of by stations, which showed that there was 6,393.73 cubic yards to be excavated, but probably this calculation was not so correct as the other would have been, owing to the way in which it was made.

Thus, submitting our report May 16, 1887, and recommended to the Court that if actual values only were wanted, without regard to grades, that the second and third reports were as near the true result as we could reach. But if the Court preferred to maintain the Miller grade, the fourth and fifth reports would be more nearly the desired result

On the 6th day of June, 1887, a motion was made to set aside the several reports, on the grounds of their disagreement, and the impossibility of finding out just the exact amount to be excavated, but was overruled by the Court The case was assigned for June 13, 1887, and continued at defendant's costs until July 5, 1887, when the case was again continued to the next term of Court, and was tried December 3, 1887; a motion for a new trial was filed and overruled January 3, 1888

April 30, 1888, judgment reversed by Circuit Court, and case remanded for new trial before Common Pleas Court, on the grounds that Miller was appointed on the ditch before he had given his official bond, forgetting that he was reappointed after his official bond had been given.

This case would have been carried directly to the Supreme Court from the Circuit Court, but the way suit was brought would have necessitated the printing of all the papers in the case, which expense alone would have been more than $200.

May 14, 1888, leave was granted Miller's bondsmen to answer by June 1, 1888, and June 30, 1888, filed first amended petition.

November 30, 1888, demur to amended petition sustained as to Miller's bondsmen, and December 17, 1888, a second amended petition was filed, and case will, in all probability, go to the Supreme Court before it is settled.

If the courts and attorneys proceed in this case with their usual degree of slowness, the young land-owners along this ditch will become hoary-headed before they shall receive any redress for their grievances. We give you the above statements, showing how time can be wasted in litigation.

The land-owners becoming convinced that the courts would be of no immediate benefit to them, petitioned the Commissioners in January, 1888, for a new ditch, which was granted, and the writer appointed engineer.

In the spring of 1888 the estimates for the work were made, with the usual hearings, and the ditch was sold July 7, 1888. The parties living at the upper end of ditch petitioned only for an outlet, and with the Commissioners agreed to start it a sufficient depth below the natural surface to accommodate the ditches above, which was 4.3 feet.

The grades and terminus of the ditch, which are as follows, being left entirely to the judgment of the engineer:

From station 0 to station 120, a grade of 0.1 foot per station; from station 120 to station 146, a grade of 0.19 foot per station; and from station 146 to station 182, a grade of 0.12 foot per station, where the outlet terminates in the botton of the old ditch. The ditch was constructed one foot wide in the bottom, with side slopes of two feet horizontal to one foot vertical, with a total excavation of 33,489 cubic yards.

This ditch was sold at the low figures of $3,171.92, ranging from eight to fourteen cents per cubic yard.

At the lower end of the ditch quicksand was struck in various places, showing that a greater depth was not practicable. This work is nearing completion, and it will not be out of place to say that these contractors will not get rich on this kind of work at the above prices.

DISCUSSION.

Mr. Mattison: I would like to inquire as to the character of the soil where this ditch was cut?

Mr. Davisson: The soil at the upper end of the ditch is a black loam; at the lower end it is a black loam and clay and gravel soil mixed.

Mr. Mattison: What was done with the material taken out of the ditch?

Mr. Davisson: It was scraped back from the ditch, and leveled off to a width of thirty or forty feet.

A member: I presume all the work was done with scrapers except these slopes?

Mr. Davisson: They did it all with scoops. They keep the team on the bank, and attach the team to the scoop by a chain six or eight feet long. They will take out three or four scoops in five minutes time. They keep their team out of the ditch, and there is a man in the ditch who drags the scoop back into the ditch. By this system one team and two hands will take out dirt faster than a dozen men would shovel it out.

Mr. Mattison: How many yards can they remove in a day in that way?

Mr. Davisson: Well, that varies; I have seen them remove a hundred cubic yards where the bank was dry; sometimes, of course, they would not remove over fifty, when it was muddy.

Mr. Mattison: Wouldn't they remove more when it was muddy than when it was right dry?

Mr. Davisson: When it was wet the ground becomes muddy where the team works, and also the man who drags the scoop back into the ditch has a heavy load.

Mr. Mattison: Do they use a plow in the bottom of the ditch before scooping?

Mr. Davisson: Yes, sir, they generally plow it before scooping it.

A member: What kind of a machine is that scoop?

Mr. Davisson: Just an ordinary iron scoop.

A member: Do you think they could do better work with that than with a scraper mounted on wheels?

Mr. Davisson: Yes, sir, especially when they get down in the ditch.

A member; There is one question that I wanted to ask at the end of the ditch discussion. I would like to ask whether anyone has had any experience in pumping for drainage? To drain into some place and then pump.

The Chair: Has any one had such experience as that? If not, I have a similar question to ask. I have heard discussed somewhat, though not by professional men, as to whether, by simply digging down until we come to water, (we know that when we go down a certain distance we get water,) we could discharge the water in that way through underground streams? Has any one had experience in that matter?

Mr. Harper: Mr. President, something similar was attempted once in the suburbs of Cincinnati; an attempt was made by the engineer to dispose of the sewage in that way. I don't think he made the necessary examination to obtain the data, and the result was that after going some fifteen feet below the surface, the well filled about three-fourths full, and it was impossible to dispose of the drainage in that way. It was a gravel formation, and it was expected that the sewage matter would be disposed of by percolations through the ground, but it proved to be one of the most successful failures ever you saw.

The Chair: I would not think of disposing of sewage in that way.

Mr. Scott: There have been some wells, such as you speak of, put down in our county, near Tiffin, and I examined one last summer. An old friend of mine up there took me out to his well, and said it was no use to talk to him of ditches any more; he had a well put down about eighty feet deep; they struck rock containing a fissure or cavity, and he had a box fixed all around the top of it, and he had an 8-inch tile and two 6-inch tiles running into that. At that time it was draining an area of about 200 acres. He claimed that it drained the land sufficiently to protect the crops, which I rather doubt, from the looks of the crops. In the 8-inch tile there was about four inches of water running into it, and in the 6-inch about the same. I noticed he had quite an open

ditch running away from his well. I think it is practical in some cases where you are sure you can strike a cavity in the rock, and I think where you can dig down into a gravel formation it would probably answer for small drainage, but I hardly think you could do much in that way.

Mr. Harvey: I think it would be practical to suggest here that engineers should pay a little attention to the formation of the strata before they tried too many costly experiments. The Clinton limestone is more porous than the Cincinnati limestone. You can hardly find such fissures in the Cincinnati limestone; but I think you would fail a hundred times in this method of drainage where you would succeed once.

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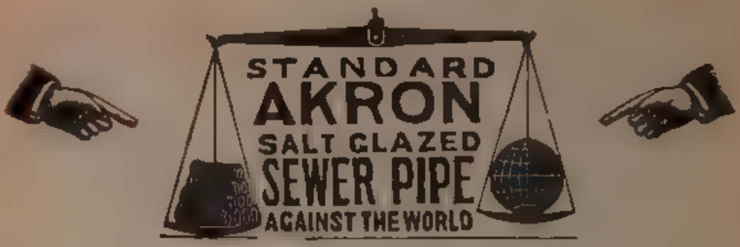

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Eleventh Annual Report

OF THE

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OF

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AT ITS

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Minaugh, J D	Civil Engineer and Surveyor	New Lexington, Perry Co., O.
Morgan, Arthur L	Assistant Engineer Chattanooga Land, Coal and Iron R'y Co	Chattanooga, Hamilton Co., Tenn.
Mullin, John H	Mining Eng'r & Gen'l Sup't Ft. Payne F'ce Co.and Ft. Payne Coal & Iron Co.	Ft. Payne, DeKalb Co., Ala.
Nicholson, George B...	Chief Engineer Cin. N. O. & T. P. R'y Co. and Associate Roads	Cincinnati, Hamilton Co., O., 85 West 4th St.
Opdycke, E. B	Civil Engineer	Bryan, Williams Co., O.
Pampel, D. W	Surveyor and Civil Engineer	Sidney, Shelby Co., O.
Peters, Wm. E	County Surveyor	Athens, Athens Co., O.
Pritchard, Jesse A	Chief Engineer Lake Park Land R'y and Imp't Co	Tacoma,Pierce Co.,Washington. 906 Pacific Ave.
Pugh, A G	General Contractor	Columbus, Franklin Co., O.

NAME.	BUSINESS.	RESIDENCE.
Raudabaugh, John.....	Surveyor and Civil Engineer	Celina, Mercer Co., O.
Reno, J. M............	Civil Engineer..........................	Youngstown, Mahoning Co., O.
Riggs, Morris J........	Civil Engineer..........................	Toledo, Lucas Co., O.
Rock, Sam'l F.........	Chief Engineer O V. I. & C. Co.......	Nicholasville, Jessamine Co., Ky.
Sager, Fred J..........	Civil Engineer..........................	Columbus, Franklin Co., O.
Scott, J. W............	Civil Engineer and Surveyor	Marion, Marion Co., O.
Seitz, D. W............	County Surveyor.......................	Ottawa, Putnam Co., O.
Sharon, William S.....	County Surveyor..................	Springfield, Clark Co., O.
Sheldon, A. D.........	County Surveyor and Civil Engineer..	Whittlesey, Medina Co., O.
Snyder, Frank.........	Civil and Hydraulic Engineer	Columbus, Franklin Co., O.
Stattleman, G. R.......	Civil Engineer..........................	Dayton, Montgomery Co., O.
Strawn, J. B...........	Civil and Sanitary Engineer...........	Salem, Columbiana Co., O.
Sturgeon, Charles......	Representing Columbus Sewer Pipe Co.	Columbus, Franklin Co., O.
Thompson, Benj........	Civil Engineer..........................	Chattanooga, Hamilton Co., Tenn
Turner, Frank M......	Civil Engineer and Surveyor	Dayton, Montgomery Co., O.
Varney, J. D..........	Civil Engineer and Surveyor	Cleveland, Cuyahoga Co., O. 52 Public Square.
Van Atta, H. B........	Civil Engineer and Surveyor	Nelsonville, Athens Co., O.
Weddell, John B.......	City Civil Engineer....................	Galion, Crawford Co., O.
Weber, Harry L.......	City Engineer	Bucyrus, Crawford Co., O.
Weitzell, R. S..........	Civil Engineer..........................	Weatherford, Parker Co., Texas.
White, Homer C.......	County Surveyor.......................	Warren, Trumbull Co., O.
Wickenden, Thos. R...	City Civil Engineer.......	Toledo, Lucas Co., O.
Wileman, Erasmus D..	Civil Engineer and Surveyor	Massillon, Stark Co., O.

HONORARY MEMBERS.

NAME.	BUSINESS.	RESIDENCE.
John Graham..........	....	Columbus, Franklin Co., O.
R. W. McFarland......	President Miami University...........	Oxford, O.
T. C. Mendenhall......	Sup't U.S. Coast and Geodetic Survey..	Washington, D. C.
John N. Lewis.........	....	Mt. Vernon, O.
George H. Frost.......	....	New York City.
Dr. Edward Orton.....	State Geologist	Columbus, O.

ELEVENTH ANNUAL REPORT

OF THE

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS

The Eleventh Annual Meeting of the Ohio Society of Surveyors and Civil Engineers was held in the old Board of Trade room, City Hall Building, on State Street, Columbus, Ohio, January 21, 22, and 23, 1890.

The Society was called to order at 9:30 o'clock A. M. by President B. F. Bowen.

The exercises of the meeting were conducted essentially according to the following

PROGRAM

TUESDAY, JANUARY 21—9 A. M.

Meeting of Trustees and Committees, and arranging of Displays.

TUESDAY, 1:30 P. M.

Report of Secretary.

Report of Treasurer.

Report of Trustees.

Election of Members.

Report of Committee on Code. J. D. VARNEY, *Chairman*, Cleveland.

Report of Committee on Legislation. W. H. JENNINGS, *Chairman*, Columbus.

TUESDAY, 7 P. M.

PAPER—"The Motor in Engineering," Professor B. F. THOMAS, Ohio State University.

Report of Committee on Civil Engineering. GEORGE B. HARPER, *Chairman*, Cincinnati.

WEDNESDAY, JANUARY 22—8:30 A. M.

Report of Committee on Surveying. J. T. BUCK, *Chairman*, Cardington.

PAPER—"County Surveyors, and the Laws Under Which They Work," WM. PETERS, Athens.

Report of Committee on National Public Works. BENJAMIN THOMPSON, *Chairman*, Chattanooga, Tenn.

Address by Hon. PHILLIP BRUCK, Mayor of Columbus.

Address of President, B. F. BOWEN, Columbus.

WEDNESDAY, 1:30 P. M.

PAPER—"The Condition and Needs of the Engineering Profession in Ohio," SAMUEL BACHTELL, Columbus.

PAPER—"Sewage Disposal," Dr. EDWARD ORTON, Ohio State University.

Report of Committee on Drainage. D. W. PAMPEL, *Chairman*, Sidney.

PAPER—"The Sewerage of Columbus, Ohio," FRANK SNYDER, Columbus.

WEDNESDAY, 7 P. M.

PAPER—"Maps of the Coast and Geodetic Survey," Prof. T. C. MENDENHALL, Superintendent United States Coast and Geodetic Survey.

PAPER—"Water Works for Towns and Villages," J. B. STRAWN, Salem.

PAPER—"Rural Water Supply," J. ARNETT, London.

THURSDAY, JANUARY 23—8:30 A. M.

Report of Committee on Highways. WM. SHARON, *Chairman*, Springfield.

PAPER —"Maintenance of Permanent Way on Railroads," A. W. JONES, Columbus.

PAPER —"Notes on Natural Gas," H. L. WEBER, Bucyrus.

THURSDAY, 1:30 P. M.

Report of Committee on Blanks and Instruments. J. B. STRAWN, *Chairman*, Salem.

Unfinished Business.

New Business.

Election of Officers.

Treasurer's Report.

COLUMBUS, OHIO, January 23, 1890.

To the Officers and Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—I herewith submit the following statement of the receipts and expenditures of the Society during the year 1889, as follows, to-wit:

RECEIPTS.

Received from sale of Annual Reports	$ 7 59
Received from membership fees	48 00
Received from annual assessments	338 00
Received from advertisements	40 00
Received from donations National Public Works Com.	22 00
Total amount of collections for 1889	$455 59

EXPENDITURES.

Printing Annual Reports	$212 92	
Hall rent and janitor's fees	31 00	
Other printing and stationery	18 43	
Stenographer's fees	10 29	
Drayage	3 00	
Expressage	1 50	
Postage	28 94	
National Public Works Committee	22 00	
Deficiency, 1889	150 89	
		$478 97
Expended by Treasurer in excess of receipts		$ 23 38

	Dr.	Cr.	
Assets Jan. 23, 1890—			
Due for unpaid advertisements	$72 50		
Liabilities, Jan. 23, 1890—			
For printing and stationery		$ 9 17	
For stenographer's fees advanced by C. N. Brown, Sec'y		44 16	
For cash advanced by F. J. Sager, Treas.		23 38	
	$72 50	$76 71	
Deficiency			$4 21

F. J. SAGER, *Treasurer.*

President's Address.

Gentlemen of the Ohio Society of Surveyors and Civil Engineers:

It has become my duty as it is my pleasure to greet you at this, our annual meeting.

There is no provision in our constitution requiring the presiding official to deliver a formal address, but somehow it has grown into a custom; and, while not ambitious in this line, yet I must beg your indulgence for a brief reference to our Society and the progress of our work. There will be no attempt, however, to go into minute details of any special branch, but only give a cursory resume and the relation of surveying and civil engineering to the material developments throughout the country.

In January, 1879, a few of the faithful of our Society met in this city to compare notes and discuss questions of interest, which made it apparent that we all needed more professional knowledge, a more uniform system for detail practice, and a greater degree of fellowship. This is the foundation on which we have been building for eleven years; with what success our "Annual Reports" must stand for the Society, and each member must judge for himself.

"Surveyors and Civil Engineers," in the literal sense, would seem to imply two distinct classes, yet of the same line, so closely allied however, that there is no well defined line of distinction between them, as the duty of either often requires the work of the other. By common acceptance, however, the surveyor more properly deals with lines, the relative location of places and things, and the area, extent, or surface of portions of the country. This work embraces a great variety of intricate problems, from the most complicated geodetic survey to the plainest work of laying off an acre lot.

It is the surveyor that has made the geography of our

country, thus giving to the public a better knowledge of the location of places. It is the local surveyor that determines and establishes the boundaries of individual possessions of property in land, giving to each his just proportion, and by this means contributing to the peace, dignity, and good order of society.

The engineer, as here considered, deals more with force and resistance in the construction of important work to benefit the affairs and conditions of men in civil life. Hence the term "Civil Engineer." This class of men are required to devise the ways or plans to accomplish the end sought; to supply the needs and gratify the wishes of men, to facilitate the commercial transactions of the country. To this end peninsulas are rounded off, channels deepened, isthmus cut through, mountains tunneled, hills removed, ravines filled up or bridged over, and the elements and power of nature controlled, and directed, and made subservient to the will of man.

The laws of nature with which we deal, are God's free gift to all, and we need have no fears of either trusts or combines ever monopolizing our stock in trade. The population and wealth of our country are increasing at a rapid rate, and the demand for public and private improvements are proportionately great, affording a wide field for our co-workers in which the most intelligent and studious are always found in the front ranks of the profession. Patronage in this line does not go by political favors; but as a rule, merit, when backed with energy, industry and promptness, is the winning card.

The engineer of modern times does not assume the relation to his work that Mohammed did to the mountain. But when he has anything to do with such a ponderous body, he awaits not its coming, but goes to it direct and "sizes it up," and instead of climbing over, as Bonaparte and his conquering hosts did, he goes directly through it, and when through he leaves the way clear and free for all succeeding generations. In such great conflicts between force and resistance it is not clear whether an apology is due to the mountain or to the engineer.

Engineering works of both ancient and modern times are

so numerous and varied that only a cursory view can be given to a few of the most prominent.

Canals are of great antiquity, and in their time served well the purpose for which they were intended. The canals of recent date are more remarkable for their magnitude than their mileage; most of which are short lines connecting large bodies of water, to shorten the voyages of ships — notably the Suez canal connecting the Mediterranean and Red Seas. After the successful completion of this great work, the project of the so-called "Panama" canal to connect the Atlantic and the Pacific Oceans was commenced. The information was given out that the work would cost fifty to sixty million dollars. Ten years time and three hundred million dollars have been spent, and the unfinished work is now abandoned. From the general account, it would seem more like a visionary scheme than a well defined engineering enterprise.

Very recently there has been commenced another ship-canal to connect the Atlantic and the Pacific Oceans by the Nicarauga route. This work has been undertaken from well defined engineering plans, in all their details, with fairly good prospects for success. This is an American enterprise — surveyed and planned by American engineers, and backed by American capital. We most certainly feel a deep interest in the speedy and successful completion of this great work.

There is now in progress of construction a ship-canal from Liverpool to Manchester, thirty-two miles; estimated cost about fifty million dollars.

The latest project in this line is to construct a large canal in the Illinois river, connecting Lake Michigan with the Mississippi river, to serve the double purpose of a navigable route for river and lake steamboats, and an outlet for the sewerage of Chicago. This project is in its infancy and not well matured, yet it is believed to be practicable. This being one method of that great city getting rid of its sewage elephant.

Roads or highways, streets and lanes, have always been an important feature in public improvements, and have fairly kept pace with the age. To construct these with all their bridges, culverts and drains, has been and yet is, an ample

field for the engineer. The importance of the work varies with the requirements of the case. Constructing and maintaining streets for heavy traffic in cities have grown into an important feature of our work — a specialty in itself.

About the middle of the seventeenth century, the products of certain coal mines were hauled on wagons from the pit to the wharf for shipment. By the continuous action of the wheels in the same track deep ruts were worn, and the hauling was heavy even when the loads were light. Some handy man about the place conceived the idea of laying down wooden rails for the wheels to run on. And in this "*idea*" was the beginning of the railroads of modern times. The wooden rails were laid, then one horse could haul as much as three had done before. In time, iron rails were used instead of wood, and many wagons or cars were joined together, making a train, thus multiplying the advantages. Early in the nineteenth century the question of substituting steam for horse power was fairly in the hands of the engineers, and the steam wagon of that time has grown and developed into the locomotive of the present day, with the speed of the wind and a force almost irresistible. These magnificent engines were not designed by any one man, but like Darwin's protege, have been in a state of progression ever since Watt conceived the idea.

Railroads, with all their tracks and paraphernalia of equipments, are the commercial life of the country, as they afford ready, cheap and speedy means of transportation for all commodities from one place to another, in the shortest time, and at a minimum cost. By this means the social intercourse and business relations of the people may be carried on with little delay, inconvenience and discomfort to individuals.

Street railroads are an element in our public improvements of too much importance to be overlooked. While the country is rapidly increasing in wealth and population, yet the greater per cent. of increase is in towns and cities, the growth of which in recent years has been marvelous, and some method of rapid transit has long since become a necessity, especially in the larger cities. The proverbially "slow coaches" are within the recollection of many of us. These gave place to

the "horse car" in general use, which was a great improvement, yet did not satisfy the eager haste of a busy people.

Then came the elevated roads, with the track raised above the ordinary street traffic with cars propelled by steam, and stations quite remote, so that longer runs and greater speed might be made. By this means we are able to gain time and get better results out of the motive power, and less liable to the delays and accidents incident to a surface road. The great cost of these roads however requires an immense volume of traffic to justify their construction, therefore they must of necessity be confined to large cities. So far they have proven a success where the conditions would seem to justify the venture.

Cable roads came next in order of progression. These roads have surface tracks, (rails and cars similar to the ordinary horse car lines) with a slotted iron tube laid below the surface of the street in the center of the tracks. In this tube is the cable, which is continuous with the line of road, and connected with the power stations at any convenient point on the line. The motion of the cable is uniform and continuous. The "grip-car" is so constructed that its driver may attach or detach at will. These cables usually run at about twenty miles per hour, and by the ingenious contrivance called the "grip" (which is attached to the "grip-car") the driver can regulate his train from a full stop up to the maximum of the cable's speed. Ordinary passenger cars for street traffic are attached to the "grip-car," making trains to suit the demands. The "cable system" may be used on elevated tracks the same as on surface roads. This system may not be the road for the future, but it has certainly came to stay for a long time.

Electric roads have their tracks constructed the same as ordinary horse car lines, the cars being propelled by the force of electricity, generated at a central station and transmitted to the cars through wires, either laid below the track or suspended above it, or by storage batteries attached directly to the car. This system is no longer considered an experiment, as it has been used with good results. There are now in this country about one hundred lines of electric roads, with over

four hundred miles of track. The economy of construction especially recommends this system.

With all the various stages of progress in the methods of transit, step by step, and year by year, yet it has remained for the year 1889 to produce the greatest innovation of the age, to-wit: The hydraulic or sliding railway. Such a one has been in operation at the Paris Exposition the past summer. Briefly described, it has flat rails, the cars provided with sliding corrugated shoes instead of wheels; each car carries a tank filled with water under a high pressure, and connected by small pipes with the shoes. A large pipe is laid between the rails, also filled with water at a high pressure, with outlets or nozzles all along the line, that may be opened and closed automatically as the car passes. Two forces are necessary—one through the small pipes connected with the shoes which raise the car from the track and sustain it on a film of water. The nozzles in the large pipe are opened and the jets of water impinge against turbines or buckets on the under side of the car, and slide it forward. The sustaining film being supplied continuously and the propelling jets being constant, the two forces supply the motive power. It is claimed that steep grades or short curves do not materially affect the speed, and that a velocity of one hundred and twenty miles per hour may be maintained. This speed would seem sufficient to satisfy the most eager haste. When the claims of Gerrard are realized and all these theories reduced to practice, then we may all go tobogganing up hill as well as down.

The first principles of our work are plainly laid in schools and colleges. But the most useful lessons are only learned in the broad school of experience. New work develops new conditions which may require methods not previously laid down in the text books. In this way our stock of empirical formula is increasing. Hence the necessity of keeping up with the progress of the profession as it develops into new fields. By a mutual exchange of ideas and a general discussion of subjects relating to our business, we stimulate the energies, inspire confidence and incite research; and by this kind of professional friction we are more likely to keep up

with the age in which we live, and get the most out of life, which at best seems too short.

The science of our work is not an open book—so plain that he that runs may read. Yet the doors along the line are sufficiently open for all, who will, to enter; and it is hoped and believed that our members will, like Poe's raven, ever keep tapping at the doors.

And while yet in the vigor of our strength, may we make haste to overcome the up-grades of our work 'ere we reach the zenith of our time. And then, may our line be straight and the grade easy. And may daisies, violets, asphodels, and hyacinths enliven our pathway to the end.

Report of Board of Trustees.

To the Officers and Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—Your Board of Trustees, whose duty in part is to examine the books of the Treasurer of the Society, would respectfully report that they have attended to that duty, and find that they have been correctly kept. We have also fixed the assessment per members for the year 1890 at $3.00.

Respectfully submitted,

J. D. VARNEY,
JULIAN GRIGGS,
JOHN HARVEY,
H. B. VAN ATTA,
J. M. HARPER.

Election of New Members.

Mr. Varney, Chairman of Committee on Applications, submitted the following names of applicants for membership in the Society, which had been favorably reported upon by the committee:

Thomas C. Connar, Zanesville, Ohio.
Phillip J. Laessle, Chillicothe, Ohio.
Arthur L. Morgan, King's Creek, Ohio.
E. D. Wileman, Massillon, Ohio.
W. H. Gaffney, Logan, Ohio.
John C. Grim, Bryan, Ohio.
Fred J. Cellarius, Dayton, Ohio.
Herman S. Fox, Dayton, Ohio.
Frank M. Turner, Dayton, Ohio.

Upon motion duly made and passed, the Secretary was instructed to cast the vote of the Society for the admission of the applicants above mentioned. Same was done and the above named persons declared elected to membership in the Society.

Election of Officers.

A nominating committee, consisting of Messrs. Sager, Strawn and Harvey, was appointed by President Bowen, with instructions to retire to make their selections at once.

The committee on nominations reported the following ticket, the same being elected as reported, separate ballot being had on each name:

For President—J. T. Buck.

For Vice-President—J. R. C. Brown.

For Secretary and Treasurer—Julian Griggs.

For Trustees—B. F. Bowen, Edwin D. Haseltine, W. H. Jennings, C. N. Brown.

Instructions to Secretary.

Secretary was instructed by vote of Society to publish with the forthcoming issue of the proceedings of this convention a list of the members of the Society; also to distribute among the members the remaining copies of the Constitution and By-Laws of the Society.

Vote of Thanks.

Upon motion of Mr. Jennings, a vote of thanks was tendered the retiring officers, especially F. J. Sager, for his labors to place the Society on a firm financial basis.

Upon motion of Mr. Jennings, the Secretary was instructed to tender to the Board of Trade, on behalf of the Society, a vote of thanks for the use of the meeting room.

Time and Place of Twelfth Annual Meeting.

After some discussion on the subject of time of holding the next annual meeting, it was decided to hold it in Columbus, Ohio, January 20, 21 and 22, 1891, as it seemed to be more satisfactory in a number of particulars than to hold the meeting a week earlier, as has been the custom.

Members are urged to begin preparations for the next annual early in the year, and complete their papers before the meeting, so that they can be at once turned over to the Secretary for publication. The Report might be issued each year by the 1st of April if this were done, and the suggestions it contains would then be available to members for their season's work, consequently adding to the value and prosperity of the Society. Suggestions, questions and problems to your officers and committees will be in order at all times, and greatly assist and encourage them in their work.

Report of Committee on Code.

GENTLEMEN—We cannot offer a sufficient excuse for not having accomplished more results in our work, but we wish to renew the recommendation of our predecessors, that the duty of issuing the Code should be transferred from the Secretary of State to the Auditor of State. Further, we have satisfied ourselves that there would be no opposition to this change, and we feel that in the near future steps should be taken to secure this and the publication of a new Code, which shall embody such instructions as will be approved by our Society as being in accordance with the best practice.

J. D. VARNEY,
Chairman of Committee on Code.

Report of Committee on National Public Works.

To the Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—Your Committee on National Public Works beg leave to submit the following report:

Immediately after notification of appointment, the Chairman addressed a letter to the Secretary of the Council of Engineering Societies on National Public Works, asking for information as to the status of affairs at that time, and in addition asking what share of the work was assigned to your committee, stating that we were willing and anxious to do what we could to help accomplish the plans and purposes of the Council. To this letter no response has been received. In course of time a letter of similar import was addressed to the President of the Executive Board of the Council, but up to the present no response has been received from him.

After some consideration, the committee has concluded upon no course of action to accomplish anything in the line of their appointment, having received no information from the Council whereon action might be based. Under the circumstances, it might not be out of place to consider the advisability of severing the Society's connection with the Council.

Respectfully submitted,

BENJ. THOMPSON, *Chairman.*

Report of Drainage Committee.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

Your committee submits the following report, which it regrets to admit has not received the care and consideration this important subject deserves. It is scarcely second in importance to the crops of a large area of this country, or to the price and value of the crops themselves.

The value and influence of drainage where needed upon the products of the soil is so fully appreciated and recognized that it is not necessary to dwell upon this part of the subject. The best and most practical methods of accomplishing needed and proper drainage is a subject for observation, investigation and study for the engineer. You who lay out county, township or private ditches know how important a matter the proper location is, especially that of an open ditch. Open ditches ought always to be laid out with the greatest care in reference to straightness, and where practical they should be laid out on, or along surveyed land lines, section or sub-division lines or roads. The ditch should not be turned out of its right course for the intervention of a little undulation, even if it involve a little extra depth, which might be compensated for by shortening the ditch and consequently increasing the fall per station. It often happens in locating a ditch through woods, brush or other obstructions which prevent starting on the right course that we run into too high ground and are compelled to change the course a number of times, making unnecessary bends. Such lines should be re-run and made straight the longest possible distance, and where such angles must be made the line should be carried backward or forward to a section, sub-division or land line where it is practicable to do so. In this way open ditches can generally be located straight through each tract of land, thus making it more convenient for cultivation and more sightly and beautiful, while its straight course will give it a free and rapid flow, and thus discharge a greater volume of

water in a given time owing to less friction on account of fewer bends.

The bottom of an open ditch should be at least two feet below the necessary depth of tile drains to prevent the tile from being filled up and obstructed by the ever-accumulating sediment in the bottom. Probably the best way to treat this deposit of sediment would be to make bank slopes not to exceed two to one, or still flatter, which will greatly reduce the cost of cleaning out the ditch and keeping it in repair, by plowing and scraping out the deposit and spreading it on the adjacent land.

Open ditches should not be made except where they are absolutely necessary. The reason is obvious; a tile drain will generally cost but little if any more than a properly constructed open ditch with sufficiently sloping banks. Fields can be cultivated, hauling done in less time, and with less inconvenience, beside the additional ground to cultivate which would be waste land if the ditch was left open. There is a constant demand for the deepening and widening of ditches, and this demand will continue until their bottoms are sunk low enough not to obstruct the discharge of the tile drains. This continual demand for deepening and widening is a strong argument in favor of the best location. In many cases an entire new ditch could be constructed on a proper location for the same expense that would be required to deepen and widen the old crooked ditch to the same dimensions, thus making the entire cost of the old ditch a total loss, whereas if it had had the proper location in the beginning this waste and loss would have been saved, and all work heretofore done would have been in the right place and the additional work would only be so much added to what was already properly under way to complete the work to a practical and satisfactory result. Bad locations are not always the result of carelessness or neglect on the part of the engineer. Many times he is compelled by a board of commissioners or trustees to make a location and specification of a ditch which he knows is unreasonable, unwise and unjust, because some land owner or somebody else has a whim, that he wants the ditch located here or there, or somewhere else,

or to follow the meanderings of the old water course; that to straighten would make two ditches instead of one; that it is his land, and if he is content with a crooked ditch it is no one else's business. Boards will often be governed by such persons' desires or demands and thus injure and abuse a public necessity and improvement as well as interested land owners above and below.

The subject of underground drainage is often a matter of only a private nature, but its importance is scarcely second to open ditches. There is no fixed rule by which the exact dimensions of a required drain tile can be determined. The conditions are so various, depending upon area drained, fall, quality of soil, and the ever-varying amount of rain fall, to say nothing of the shape of the cross-section and uniformity of the tile, and the degree of approximation to a plane with the bottom of the tile, so that engineers have a large field for observation and investigation to determine the absolute requirements and needs for a perfect system of drainage suited to their locality.

D. W. Pampel, *Chairman*,
Sidney, Ohio.

Report of Committee on Blanks and Instruments.

If we may be permitted to offer a few words by way of preface to our report, we would say that it is an indisputable fact that the engineer has done more to improve and beautify this great country of ours, which by nature is the finest in the world; has done more to reclaim and make beautiful and healthful those lands which by nature were forbidding and unhealthful; has done more to unify the peoples of all climes, nations and conditions; and that eventually he will be credited with doing more to bring "peace on earth and good will toward men," than any other profession or class of men. The new fields which are inviting him to enter, the demands for higher grades of work in every department now occupied, have stimulated manufacturers of instruments, and of the various appliances and supplies which the engineer must have, to come into closer relations with the profession than heretofore. At present, every manufacturer of engineering instruments, if he wishes to keep pace with the improvements of the age, is anxious to know what the engineer wants, and is willing to remodel, refit, and refurnish his whole shop or factory, if need be, provided he can supply the engineer with just what he wants. The manufacturer attends the engineers' meetings, listens with wrapped attention to all of the proceedings that nothing may be lost. His great desire now is to find out what must be done to keep pace with this advancing army of adventurers into the hidden parts of the earth. The manufacturer no longer sits placidly in his office and waits for his customers to come to him. He *goes* for them; but, not to tell them what they should have, nor how they should be fitted out. Not so. The engineer is the teacher; the instrument maker the pupil.

It has been the engineer who has improved and perfected the field instruments to what they are to-day. Otherwise we should have the same clumsy old instruments, similar, possi-

bly, to those used by the Chinese four thousand years ago; and there in use to-day, as then—a rude compass, conveyed upon a wooden wheelbarrow.

The engineer may now order his instruments of any desired size, weight, kind of metal, power of magnifying glasses, definition, graduation, and number and kind of attachments; and the manufacturer does not *dare* say he does not make that kind of an instrument, but goes to work and furnishes *just* what is wanted.

In the exhibits of instruments before this Society, reaching back for ten years, it has been very gratifying to note the interest manifested by instrument makers, to try to anticipate the engineers' wants, as well as to adopt such improvements in construction as have from time to time been discussed and recommended. The transits of to-day are far superior to those of but a few years ago. The same is true of levels. The instruments now are made both *lighter* and *stronger* than they formerly were. Useless metal has been eliminated from the heavy cumbersome instruments, and the weak points strengthened. The arrangement of the several parts used in manipulating the transit are much more convenient in the new make than in the old. The transits and levels exhibited by Keuffel & Esser, of New York, at this meeting are notable examples illustrative of what we have just said. The general make-up of the instruments attract attention for their compactness, fine finish, careful graduation, solidity, convenience of manipulations, the quality of metal used to give greatest strength and durability, with lightness; with new devices for protecting the instrument from injury by rough handling; with improved clamping screws; and shades to verniers which act as protectors and reflectors. Many other improvements are promised from this enterprising firm on their transits. Their instruments for a high grade of work in leveling are worthy of special notice.

What we have said of the above exhibit by this firm, may with equal propriety be said of the instruments manufactured by James W. Queen & Co., and likewise exhibited at this meeting. This firm manufactures every part of their instru-

ments, which bear careful examination. They are firm, neat and accurate.

The fine display of scales by Keuffel & Esser is worthy of special mention; likewise their steel tapes and drawing instruments.

The display of James W. Queen & Co., of Philadelphia—two transits, one level, extensive variety of draughting instruments, scales, inks, pencils, field books, profile and cross-section paper—with many specialties adapted to the wants of the profession. A noticeable little instrument is their R. R. dotting pen, invented by their agent, Mr. Speckman. A new feature was noticed in the construction of their arrangement for fastening the instrument to tripod, which is by a clamp. All of their instruments are interchangeable, and can be used on same tripod.

Other manufacturers had purposed being in attendance with displays, but owing to the prevailing epidemic, *la grippe*, were prevented.

The committee have little to say upon the subject of "*Blanks*." We might leave this part of the report at this point as a sample. However, we may say that the Ditch Blanks prepared by Mr. B. J. Ashley, C. E., are worthy of special notice for completeness and general comprehensiveness. We know of nothing equal to them. So long as there is no uniformity among engineers, respecting the keeping of field notes of surveys and leveling, there is little hope of there being uniformity in field books. If the profession could agree upon a form for general work, and then for a time adhere to that form, the *trade* would very soon supply the *transit* man and *level* man with better books, and at less price than now.

The manufacturers of this line of goods are just as anxious as are the instrument makers, to know just what the surveyor and engineer want; but so long as the engineer does not know what he does really want, the book-maker must not be censured for not supplying him with the best books for his work. We see no good reason for there not being uniformity in keeping *level notes*, and in ordinary field work with the transit, there might likewise be uniformity, or practically so.

Respectfully submitted, J. B. STRAWN, *Chairman.*

County Surveyors and the Law Under Which they Work.

BY W. E. PETERS, SURVEYOR, ATHENS, ATHENS CO., O.

The duties which the different County Surveyors throughout Ohio are given by law, and are required to perform, according to the custon of each particular locality and the influence which is successfully brought to bear upon the County Commissioners, are as varied as were the colors of Joseph's proverbial coat.

I do not believe any of you who have had occasion to look up the law and know of its provisions will take issues with me, when I assert that there are no laws upon the Statute books that are so indefinite, so unsatisfactory, and fall so short of accomplishing the purposes that they ought, as the laws which govern the county surveyors, not only of Ohio but of all other States in the Union, of whose laws I know anything.

What are the duties given those officers by the laws of Ohio as they now stand? Echo answers, "What"?

To summarise, we find such officer is created for each and every county of the eighty-eight, and that a person shall be elected in each of those counties to fill said office for the term of three years or until his successor is elected and qualified. As to his duties: we find after diligent search that they are confined entirely to land surveying, and that his authority in that matter is but a step, if anything at all, in advance of anyone else who may set himself up as a Surveyor, however slight his claims to be classed as a member of that profession may be.

This state of affairs, so far as pertains to land surveying, would not be so bad were the surveyor allowed to begin at the beginning, but he is not allowed to do so. The old adage of "an ounce of preventive being worth a pound of cure" was not thought of when the office of the County Surveyor was created and provided for. As a result he is only called in to "lock the stable door after the horse is stolen."

He is called upon to construe the meaning and transcribe the same upon the surface of the earth — of the description of a deed that never had any meaning! He must make sense out of the most senseless composition that is possible to find. The hieroglyphics that the three-year-old child makes upon its slate in its efforts to write a letter to absent papa, is as daylight is to darkness when compared to the meaning intended to be conveyed in some of the deeds written by our Notaries Public and Justices of the Peace, as such.

Whoever knew of a Notary Public or Justice of the Peace, to decline to compose and write a deed because he did not know how? Their vocabularies contain no such words as "fail" or "don't know how."

The deed is written, and means—the Lord only knows what.

The technical direction, step by step, with which one is to find the lines and corners of the land is made law, equal, in force and effect, to the highest.

After this it is passed in, without let or hindrance, to that cesspool for the receipt of applied incompetency, more commonly called the "Recorder's Office." Our statutory law and the courts then step in and call it "documentary evidence," the highest and most conclusive evidence recognized by the courts. When there is a clash or conflict, as to two or more deeds, it is to be decided, according to law and courts, only by priority of record — first come, first served.

In course of time trouble arises between the parties owning the land described and those owning that adjoining. The meaning of the deed is not understood. Some one must be called to construe its meaning. On whom do they call? On the Notary Public or Justice of the Peace, who wrote the deed, to find the lines and corners? To do what he strives to tell others to do? To practice what he preaches?

No. No one ever thinks of that! But instead, a surveyor is called. He must make sense out of the most senselessly described property or he is no surveyor at all.

To add to his pleasures our courts have given him to understand that the old original surveys must govern! That courses and distances must give way to known objects. All of which

information the law places within the reach of surveyors "If the County Commissioners deem it necessary." But, since these commissioners do no surveying themselves, and know nothing of a decidedly technical profession, they scarcely ever deem it necessary.

As to just what the surveyor will do when placed between these three fires, depends entirely upon circumstances. No rule will fit more than one case.

The one subject of land surveying is all the law seems to have given the County Surveyor to do. And that is cramped, and hampered, and dictated by persons who know as little of what they talk as they know of the lay of the streets in the New Jerusalem

We certainly want a change in this matter. Since custom has so firmly fixed the making of deeds in the hands of Notaries Public or Justices of the Peace, we as surveyors should see to it that these persons who meddle with our affairs, who dictate to us, should make their descriptions mean something; do the surveying themselves or sell out and quit.

We want the law effecting the preservation of the notes of the original surveys, so changed as to place them in the office of the County Surveyor, whether the "Commissioners deem it necessary" or not.

I for one do not think them competent to judge of that matter, any more than they are fit to judge of the merits of a discourse written in the French language.

In view of all the circumstances I think the better plan, to have these notes placed in the County Surveyor's office, would be to have the laws so changed as to *require* the commissioners, at the request of the County Surveyor, to appoint two practical Surveyors to examine such notes as they may find or may be brought to their notice.

Let these men decide as to what should be recorded and turn the same over to the County Surveyor, who shall record them properly, and receive pay out of the county funds for so doing, according to the fees provided by law. And change Section 1178, of the Revised Statutes so as to require all surveyors to record, within three months whatever surveys they make,

in a book to be kept in the Surveyor's office, and provide for their being paid out of the county funds; provide also that the County Surveyor shall be paid for the surveys he is required to record.

Since the preservation of notes of a survey is more for the benefit of posterity, the people who have the surveying done, have in the stakes and stones set, all that is of practical value to them; and the courts have partially decided that such was the true meaning of the law as it now exists. This section of law should be so amended as to remove all doubts as to its meaning, and require the public to pay for that; in the preservation of which, it is most interested. Besides it would make universal a law which is only applied in spots, since in some counties the County Surveyor is paid out of the County Treasury for the recording of his surveys, while in other counties he is not so favored.

It is highly important that all surveyors, whether County surveyors or not, should record in some accessible place their surveys, because they can as legally sub-divide and establish original corners to a piece of land as any County Surveyor can, and of which the courts compel recognition. Hence the value of the preservation of their surveys.

By reason of his special fitness, the law should make it the duty of the County Surveyor to transfer all deeds of land in his county. He should be clothed with the power to require that the description of each deed should be right — that it should mean something; or at least that it have such a description as will enable him to plat the land described, in its proper place, within the original subdivision, in good substantial books to be kept in his office. If the description is wrong or faulty give him the power to prevent its going upon record.

Since surveying and civil engineering are twin professions, to a large extent, the County Surveyor should also be the County Engineer and be given, by law, the superintending of all bridges. He should be required to prepare all plans, specifications, contracts, and advertisements pertaining to the building of the same, and keep an itemized account, by numbers, of the cost of each and every bridge built. By so doing

the bridges throughout the country would be improved. The cost of their erection made less, and charge of them placed in the hands of those best fitted by professional and practical training to have charge of them. There are few surveyors who would not have as much or more experience in the art of bridge-building at the beginning of his term as the County Commissioner has at the end of his term.

All machinery for the purpose of bridge building and road improvement should be under the care and control of the County Engineer.

Section 1181 should be so changed as to require the county to furnish the County Surveyor with a full set of drawing and field instruments—especially the latter. It is an imposition upon that official to select him out from all the other county officials and require him to furnish from three to five hundred dollars worth of instruments for the benefit of the county. Every one of the other officials have every thing they reasonably need, placed at their hands. Just why the surveyor is so specially favored I am entirely at a loss to understand.

He should be required as County Surveyor to take monthly observations of the declination of the magnetic needle, as compared to the true meridian, which the Commissioners should be compelled to have established, and record the same in such a manner as to be of future use. And give him with his authority over the transfer of deeds the power to require the bearings giving in the description of all deeds to be adjusted to such true meridian, and also to require all measurements in the description of deeds to be given in some one unit, which the law should specify. Everything considered, I believe feet and hundredths of feet would be the most common and universally understood unit of measurement, and, therefore, for my part, would recommend that that be adopted.

There are a number of other things which I could cite, the change—aye, the revolution—of which would add ease, comfort, satisfaction, and pleasure in the administration of our county government, but I have already enumerated enough for my purpose, and will only add this as a summary, viz: That there are four primary or cardinal points pertaining to

the office of County Surveyor, to secure which, we, as professional men, should strive.

First.—We should see that those who aspire to fill that office are qualified. To accomplish this there should be appointed by the Governor three practical surveyors to examine all who desire to follow the profession, and, if upon such examination they appear capable to practice surveying, give them a commission to do so, and make only those who hold such a commission eligible to the office of County Surveyor.

I would in this connection suggest that the professor of civil engineering, as such professor, of the Ohio State University be appointed one of the examiners. And that to be admitted to examination, the applicant be required to have attended a school at which the principals of surveying are taught, or to have been under the tutillage of a practical surveyor for at least two years preceding his application.

Second.—Give to the County Surveyor the duties which he is, best of all others, able to perform, and see that he is given the means necessary to perform those duties to an advantage both to himself and to those for whom he works.

And, lastly, see that the office is made remunerative, or at least as remunerative as other offices are in the same county, and in this manner invite surveyors to fill the office and not allow it to go begging, and select persons who know nothing of the principals of surveying, much to the injury of the people for whom they work as well as to the detriment of the profession in general, for people are prone to judge the best by the poorest, and besides, the best must necessarily base much of their work upon that done by some incompetent, inexperienced, or careless surveyor who has preceded him.

In conclusion, I will say that the County Surveyor should be more independent of the County Commissioners. As the law now stands it is an insult to the integrity of every County Surveyor throughout the State. It virtually says that we are all a dishonest set of people, and therefore should not be allowed to do anything unless the County Commissioners "deem it necessary," or in other words deem it right.

If we are glib talkers we can induce the Commissioners

to make something in our county right or lawful, which is unlawful in the county adjoining, simply because our brother surveyor was not possessed of the faculty of influencing men, or perhaps of the ability to change the politics of men.

We want the law to mean the same thing in each and every county in the State, or, I for one, want it abolished entirely.

DISCUSSION.

Mr. Varney: While in this paper there is much to approve, there are many things mentioned of which I decidedly disapprove. The law, as at present enacted and enforced is, I think, quite defective; but yet I think the recommendations of this paper go too far. The surveys of competent men who are not county surveyors are just as valuable as those of county surveyors, and there are some surveys made by county surveyors that are *not* valuable. I would object very strongly to all surveys being recorded, even all those made by county surveyors. It occurs to me that a better plan would be, that a committee of surveyors be appointed in each county with power to pass upon all surveys, whether made by county or other surveyor, and say what shall be recorded. Something must be done to induce outside surveyors to record their surveys. I would suggest that the county pay the surveyor a reasonable compensation for such notes and surveys as are approved by the committee above referred to, after they have given same careful examination. In regard to the recommendation for having the surveyor pass upon all deeds, I think that only one thing will be necessary to cure anyone of such a notion, and that is to attempt to prepare a law that should embody that idea. I had this notion myself once and passed through the ordeal. A law must be in exact language; it must define what it means. When you say that a description of a piece of land must be good enough so that it can be platted, then you must define what this degree of accuracy is. We know that no notes are absolutely correct; if the notes are, we know that the work on the ground is not, and where will

be drawn the line of accuracy? Where is the tribunal which shall determine when any particular description or survey comes within that line? It would require a re-survey to render the decision. I understand it is the custom of some counties in the State to furnish the county surveyor with instruments. That question was submitted to the Attorney-General at one time, and I think it was decided that under the law counties are not required to furnish these instruments. I think it is scarcely proper for the instruments to be furnished by the county, for under the law the county surveyor has very few duties to perform, and the place is sought more for the advertisement to be gotten out of it, and the extra work to be gotten through it, because people think the county surveyor the best, and he gets a great deal of custom in that way. There is one recommendation made by our friend, Mr. Peters, about which I wish to speak more emphatically, and that is in regard to the use of the needle. In regard to the matter of running surveys by courses and distances, I think the sooner the profession gets rid of it, the better. Any step which improves it, and tends to make that system more reliable, is a step in the wrong direction. This method of depending upon monuments of the sky to determine the property lines of man on the earth, or to have to depend at all on the magnetic needle, is a mistake The proper way is to get rid of this custom, and do all surveying by monuments on the ground. When we wish to put something in the deed that will define a piece of ground, let us put something in the ground that will remain to be used afterwards, so that we will not have to go to the stars to find it.

Mr. Davisson: How would you put it in your notes when you move from your first corner or starting place to the second corner?

Mr. Varney: I do it by courses and distances; that is the most convenient method to describe an angle — to say north, 60° east, or something of that kind.

Mr. Davisson: But that is just what you were condemning.

Mr. Varney: Not at all; I only say let the survey depend

on monuments on the ground and not on the needle to define it. I think you will all agree with me that this use of and dependence upon the needle tempts surveyors to get along without setting monuments.

Mr. Arnett: I am not loaded down with a speech to the water's edge like Brother Varney, but I desire to contribute my little mite. That the surveyor should hold a certificate of competency and good character, I am in accord, but that from the fact that he is elected for one or two terms county surveyor that he should have all the county work, I am not in perfect accord I want to see no tarifled professions, as Brother Varney said last year. A fair field and a fair count, if you please, is what the surveyor wants. If he is honest, competent and industrious, he will share a little amount of the public patronage.

Mr. Kinnear: One matter of vital importance, I think, is in reference to the transfer of deeds. I think it should be left entirely to the county surveyor. As it now stands, the Auditor makes all transfers, and very few Auditors are competent to do this. I think this is a matter that ought to be made the subject of some legislation.

Mr. Peters then made a few remarks, in which he reiterated his former statement that more attention should be paid to the use of the magnetic needle in surveys, and he thinks it a hardship on county surveyors that they should be compelled to furnish their own instruments. Mr. Peters also thought there were cases where a very short time was given for a survey, a few hours or a day, and where the land was worth very little, where the use of the most expeditious methods were permissible.

Mr. Harvey thought a surveyor should not neglect to be accurate because the land is poor; but that it is rather a matter of future use and value that the survey should be as accurate as possible, and not so much a matter of the present.

Condition and Needs of the Engineering Profession in Ohio.

The Civil Engineering in Ohio is represented by a large number of individuals scattered in every city, county and many towns throughout the State, each individual following some special or general practice as the ability, inclination or surrounding circumstances may offer.

Here and there have been formed a few professional clubs and societies where they meet to discuss various topics and exchange ideas mutually beneficial to the profession.

The engineer in the employ of a corporation either railroad, municipal or established in a general practice, as a rule has spent more years in study and practice in fitting himself for his profession and undoubtedly performs more hours labor per day for less remuneration than any professional man known.

Take for instance the engineer who has work under his charge where periodical estimates have to be given, no matter what the condition of the ground may be during the progress of the work, he does and must personally perform this duty, often at times when the surface of the earth is so muddy that any person not an engineer would ask to be excused. Yet the only murmurings come from the boy who thinks he wants to be an engineer and who finally in the course of a few weeks or perhaps months leaves, a living example of the saying that "the boy, who will not stand breaking in, will never become an engineer." Or as an instance suppose the engineer, doing a general practice, is called upon to make a survey of the lands of some estate, plat the same, divide the estate both on the ground and plat, calculate the areas of each lot, the length of their sides, and ascertain by careful measurements on the ground whether the entire work both in office and field is correct, so that he may certify to their correctness and place his work in the hands of his employer, and have it go on record before the world to be judged by others of its merits. If the employer should be an attorney who has engaged the engineer to do this work, he will probably

forget to suggest that the bill rendered for such service is too little, but on the other hand may inform the engineer that the bill is exorbitant and suggest a reduction; however, he takes the plat and the survey upon which you may have perhaps spent a month in field and office work, and the bill calling for perhaps $150 and files them with the court along with a bill for his own services ranging from $500 to $1000, while the time spent by him did not occupy one-tenth part of that required by the engineer to perform his work — many of you present no doubt can call to mind some experience of a similar nature.

Why should not a chief or division engineer, as the case may be, of any of our railroads of prominence in this State receive from $3000 to $6000 per annum for their services which requires them to devote their entire time to their duty? Or why should not any Civil Engineer of any of our cities containing a population of 60,000 or more receive a similar sum for their professional services? Why should not any engineer doing a private business receive $20 for the survey and plat of a city or town lot instead of, as is often the case, less than half that sum? Similar additional cases could be mentioned in relation to all branches of the profession, but perhaps enough have been cited and I will proceed to call your attention to a recent law passed during the past session of the Legislature. But few are probably aware of the existence of this law, its import or what may be done under its provisions I refer you to Sections 4 and 5 of Senate bill No. 147, found on page 120 of Volume 86, (O. L.) which reads as follows:

"SECTION 4.—Any civil engineer who shall be employed as chief or assistant engineer in the surveying, platting or cross-sectioning of any railroad, canal, turnpike, plank road or other public road, shall, before the work is commenced, make an accurate measurement of the same, and shall prepare a profile of each section of one mile or less of said work, showing quantities of each and every class of work to be done on said mile or less; and shall also designate the nearest bench-mark or point from which measurements are made, and shall drive stakes at top of slope, at foot of embankment, at side and center of grade and around every burrow pit for each one hundred feet, show-

ing in plain figures by feet and tenths of a foot the depths of cut or height of fill or embankment, together with a correct showing of the quantity of overhaul beyond a given number of feet, in cubic yards, for each section of a mile or less; and it shall be the duty of such chief or assistant engineer to furnish on demand, when any work is finished, to any company, contractor, sub-contractor or person a final statement of quantities in each class of work done or supplies or material furnished by parties interested."

"SECTION 5.—Any civil engineer or assistant engineer, whose duty it is to ascertain quantities from actual measurement, and on which final estimates are to be made, who shall knowingly give other than true quantities, with intent to defraud the construction company, contractor, sub-contractor, laborer or pèrson furnishing supplies or material, shall if the amount of the discrepancy exceed at the contract price, thirty-five dollars, be deemed guilty of a felony, and shall be punished by a fine of not less than the amount at contract price of all work done or material furnished and not included in his final estimate, or be confined in the penitentiary for not less than one or more than five years."

Here are certain requirements which, under certain cases, where unscrupulous parties have to be dealt with and unless the engineer becomes the pliant tool of one or the other, contractor or employer, he is liable to a heavy fine or imprisonment in the penitentiary. How will you prove your good intentions if, in a large amount of work, your young assistant either through negligence or ignorance makes an error that may reflect against you and for which you are held responsible? The unscrupulous contractor will hold this law as a club over many to produce submission to his will.

Among the needs of the profession, of which I will now mention a few, the first and most important is for us all to unite throughout the State as a body and urge the members of the present General Assembly to repeal this unfair law or modify these sections so as to remove their objectionable features.

I would suggest that, in order to elevate and give dignity to the profession, this association work in connection with other

ineering associations and clubs of this State in formulating act to be passed by the present General Assembly, requir-all Civil Engineers and Surveyors of this State to be licensed eceive a diploma before being allowed to practice their call-

I am aware that this is an innovation and may be objected y some, but I am of the opinion that we should be author-by law the same as attorneys, physicians, or even the men run stationary engines.

I have served in many capacities in the profession and n my observation and experience, would suggest that there three grades established as follows: the first and highest, of civil engineer; the second grade, those parties who are able of doing surveying in cities and might be termed city eyors; the third and last and by far the most numerous s, that of country surveyor. This would allow those compe-to take one or more grades.

I would suggest that a board of three be authorized to pass n the qualifications of each applicant and award them a oma according to their respective merits. That board I ld have consist of the President of this Society, the professor ractical civil engineering of the Ohio State University, and third member to be chosen by them.

In cities of the first class I would have local boards ap-ited by this board who would examine and certify to the tral board as to the qualifications of applicants for authority ractice in their cities. The qualifications of the country eyor might be passed upon by local boards, established at venient places in the State and these boards, like the city rd, also certify the qualifications of applicants to the central rd upon which they can issue.

As to the qualifications in engineering, I would suggest a certain number of years of practice — say seven — stand ualifications upon which to issue a diploma, or if the appli-t be a graduate of some college or university, let the four rs spent there stand for four years practice. A similar n of years, seven, for city surveying, and no deduction made time spent in college; a fewer number of years practice country surveying will do.

The law should be so drawn that no person would be eligible for any office in this State requiring the practice of these respective grades unless they had been by law authorized to so practice; provided, however, that this shall not interfere with the term of any person so holding office at the time of the passage of the act.

The fee for issuing such diploma or certificate should be sufficient to make the provisions of the act self-sustaining, and all funds, thus derived, over and above the amount required to pay the boards a reasonable fee, be turned into the sinking fund of the State.

Brethren, I have simply given you my views after much thought upon this subject, and believe that if some act like the foregoing were in force, (I do not say it is the best that could be devised), it would be a vast improvement on the present condition of the profession. I feel certain that when these conditions are enforced, the members of the profession can demand and will receive the proper remuneration for their services, and our profession be more highly esteemed and honored among men.

DISCUSSION.

After the reading of the above paper, a member asked Mr. Bachtell, the author of the law above mentioned.

Mr. Bachtell: He is a member of the Senate from Scioto county.

Discussion on this paper was renewed the next day by Mr. Mathewson, who said: In his paper read yesterday afternoon, Mr. Bachtell referred to some laws which were passed last winter, and this matter, I think, should have further attention from the Society. I move that the Committee on Legislation be instructed to prepare suitable amendments to these laws, and take such action as will be necessary to do away with the effects of the laws mentioned as they now stand.

Mr. Griggs: I am very much interested in this matter, and think it should receive attention. The author of this bill filed suit yesterday against the Scioto Valley Railway Co., for

work done in 1887. At the time, I furnished the contractor, for his engineer employed to remeasure the work, a full copy of all my cross-section notes, and also sent my assistant on the ground to give any additional information that was desired, saying that any errors that he should discover would be speedily rectified. I think it mischievous legislation, and that some decisive action should be taken in regard to it.

Motion of Mr. Mathewson seconded, put to vote, and carried unanimously.

A paper on Sewage Disposal, by Prof. Edward Orton, is not available for publication, the reading of which was followed by loud applause and discussion as follows:

President Bowen: If there are any gentlemen present who can give any additional information on this subject, we would like to hear them; and any questions on the subject are now in order.

Mr. Harvey remarked upon the depletion of rich soil in some sections, stating that in one portion of his own county, in twenty years he had lived to see land depreciate in value one-half, while the level lands on the east side had increased in value by careful cultivation until it had doubled. He thought it was the duty for all to send their sons to a place where they could get the right kind of an education, where they could learn either engineering or agriculture — to our Ohio State University.

Mr. Snyder: I would like to ask the Professor if he included garbage, in speaking of sewage?

Prof. Orton: I spoke a little unguarded, perhaps, in that respect. I could not include that; I probably made the term "sewage" cover more than I meant to imply.

Mr. Jennings: I move the thanks of the Society be tendered Prof. Orton for his valuable paper.

Motion seconded, put to vote, and carried.

The Sewerage of Columbus, Ohio.

Mr. Snyder had placed on the wall drawings showing the plans in detail for the proposed intercepting sewer in Columbus, and explained same to the audience, with full details as to size of sewer at different points, manner of connecting with mains already laid, flushing arrangements, work already done, etc.

Weddell's Remarks.

Mr. Weddell, of Galion, asked if he might have the floor for a few minutes before proceeding with regular business, and that being granted him, he said:

I have been very much instructed by what I have heard here, and am very glad I came, but it seems to me we could make this order of a little more usefulness by exchanging experiences on one line or another. Our theories are all right and good, but we lack in experience. Mention was made by the gentleman from Cincinnati about contractors. Now, I think you will all agree with me that contractors are the most troublesome set of men we have to deal with, especially, if they take the contract for a less price than the work can be done for.

I have heard nothing said in regard to the construction of bridges, and think more attention should be given to it. To all engineers, good masonry is the subject of the day.

In regard to pipe laying, Mr. Weddell thought the man who laid the pipe, while being paid by the contractor, should be entirely under the direction of the engineer.

The Operations of the Coast and Geodetic Survey

BY PROF. T. C. MENDENHALL.

Mr. President, Ladies, and Members of the Ohio Society of Surveyors and Civil Engineers:

I want to express first the pleasure which I have in meeting with this Society once more. Several years ago you were good enough to elect me to honorary membership in your Society; and thus far it has been very much a one-sided affair, I am afraid. That is to say, I have gotten the honor out of it and I fear the Society has gotten very little from me. It was with pleasure, therefore, that I found myself able to come and attend this meeting of the Society, in hopes that perhaps I might do something in a small way in return for the honor you bestowed upon me some years ago.

I have several things, Mr. President, that I wish to speak of, and what I shall have to say, therefore, will be of a very rambling character. And I shall have to speak upon a good many subjects that are perhaps not very closely related to each other.

On being called a few months ago to take the direction of the Government Surveys with which I am now connected, I found, indeed, what I had really known before, that a vast amount of useful and interesting information had been accumulated by this oldest of Government scientific bureaus, during more than fifty years of its active existence. I found in the archives of this service material which I know many people throughout the country would be glad to have in their possession. Having looked over the ground from that standpoint, I determined to do what I could in the beginning to bring this material into the possession of those who might be pleased to get it and who might be benefitted by it. Briefly then, my object is to try and have the members of the engineering and sur-

veying professions throughout the length and breadth of the land understand the operations of the Coast and Geodetic Survey, in order that anything which is produced by the accurate and precise methods of that service may be available to any of the profession throughout the whole country. And then, again, I have a selfish motive in view; in order that many things which are constantly being found out and constantly being studied and observed by the members of your profession throughout the country shall be in turn put into possession, whenever desirable, of the Coast and Geodetic Survey, so that we may, in this way, feed each other and supply each, perhaps, what the other demands and has not. This is my apology for the very rambling sketch which I will try to give you upon the operations of this service.

The operations of the service are classified under seven or eight different heads, and therefore you will see in the beginning that I must treat them all with extreme brevity. Only two or three I will expand upon a little. Without mentioning them at all in the order of their importance, but in the order, perhaps, in which they might be approached by one who was approaching the country from abroad, I will first speak of the hydrographic operations upon the coast. This, of course, is a very important part of the work, but it must be dismissed by me in a very few sentences.

The hydrographic operations, including the hydrographic surveys of the coast, extend out, in accordance with the organic act founding the survey, a distance of twenty marine leagues to the sea and extending up all rivers as far as tide water. This hydrographic survey, in the character of its work, need hardly be described by me, as it is undoubtedly well understood by you. It means the sounding of the coast of the sea and rivers, and the platting of these soundings upon charts so that they may be of great assistance, as they undoubtedly are and have been for many years to mariners and all who approach the coast of the United States. I might say with regard to this matter that we are constantly improving the character of these charts by making re-surveys to a certain limited extent; and it is found that the re-surveys were even more important than the original surveys.

It is well known to all of you that the operations of the sea upon the coast are sometimes very severe, and that the coast is constantly being changed in many parts of the country, and changed in a much more rapid way than some of us may suspect. This leads to the necessity of frequent surveys and the frequent republication of these charts. These charts are issued in various sizes; perhaps many of them not larger than this (indicating chart), and some of them are twice as large. They are sold by the Government through agents established at various points upon the seacoast, at a merely nominal price. During the present year we have issued of these charts about sixty-five thousand. That will give you some idea of the extent of this feature of our work, which is a most interesting feature, and upon which I would be glad to expand. I cannot leave it however, without referring for a moment to one particular problem of hydrography that was originally, for some reason or other, very fortunately given to the Coast and Geodetic Survey, that is, beyond the twenty marine leagues to which these other operations extend. I refer to that of the Gulf Stream. Whatever is now known about the hydrography of the Gulf Stream has been the result of the operations of the Coast Survey. The Gulf Stream has recently attracted a good deal of attention by the theory that has been urged in the Eastern press very extensively, that a change in the position of the Gulf Stream has given rise to the extremely mild winter through which we have passed, until, perhaps, within the last twenty-four hours. This question is one of considerable interest, as the idea of the Gulf Stream, by wagging its tail, if I may use the expression, from side to side, may give us a cold or a mild winter, is certainly one of great importance; but I need hardly say that there is little possibility of any such influence. To begin with, if the Gulf Stream did move in that way, there is no possibility that it might in any way influence the climate more than perhaps for a few miles from the coast, and as we have had a very mild winter throughout the whole Mississippi Valley, that puts a quietus upon this theory. However, it is an established fact that the Gulf Stream does change its axis, by a very small amount. The result of the explora-

tions of the Steamer Blake, under command of Captain Pillsbury, will appear about one year from this time, and when that publication is made, it will contain, in my judgment, the best information, up to the present time, of the physical hydrography of that part of the ocean; and I should be very glad indeed to see that it gets into the hands of any person who may be interested in this subject, and who may desire to possess it at that time.

The next topic in order is the topographical survey of a certain limited portion of the coast extending usually back only a very few miles; and also what we may call the secondary and tertiary triangulation; that is, in hydrographic work it is necessary to study the nature of the land as well as the nature of the water. That leads, therefore, to a very careful topographical survey of the coast back a distance of a few miles from the shore line. A topographical survey implies what we call tertiary triangulation; that is, third in point of excellence, in which the relative position of different important points are fixed with regard to each other, and with regard to certain points that are usually determined astronomically. I may remark here in explanation and apology for some reference to the technique of this matter that very few people have any idea how a map is, or ought to be made, and very few people have any idea of the inaccuracies of a great majority of our maps, as we find them in our geographies and books of that class, and even in the large atlases at the present time. An island is an island to the ordinary map-maker, and he pays little attention to its form, or some times very little attention to its dimensions, and perhaps occasionally very little attention even to its position. So you will see what we are accomplishing by our work, aside from making known the actual hydrography of our coast, so that vessels approaching it will know where they are, and know where they may go with safety. We are also making some progress toward accurate and precise map-making in this country.

The next, and one of the most interesting and important operations we have is the primary triangulation of the country. The primary triangulation of the country means the extension

of a series of triangles entirely across the continent, along several different lines and also vertically across the country in this way (indicating) along several different lines, and eventually it must mean the covering of the whole country with a system of triangles. On every apex of every triangle there will be a station, and at that station instruments must have been placed at some time, and all angles between lines connecting stations very carefully measured, thus completing the final map-making of the country by a system of primary triangulation.

I ought to say, perhaps, a word or two about the method by which this is done. A base line accurately and actually measured is the beginning of it all. This base line is usually from four or five to eight or ten miles in length, although it is now thought to be best to have a base line rather shorter than eight or ten miles. Modern base line practice looks rather to shorter lines than to longer lines. These are measured with the very greatest accuracy. In the first place, a suitable location in some part of the country is selected; that is, a place that is almost level, or as nearly level as possible; and if it is not already level, care is taken to smooth off the surface so as to have a line as nearly straight and as nearly level as may be. The practice in the United States Coast Survey has been to measure base lines by means of base bars, composed of two metals, so that no correction for temperature is supposed to be required. These bars are carried along and placed end to end, very delicate means being used for making the contact, and in that way the entire base line is measured. This base line measurement has been carried on with a very high degree of accuracy, and they have been measured more rapidly in America than in any other country in the world, and with perhaps as high a degree of perfection as in any other country in the world. The most recent measurement of a base line is the Los Angeles base line, which is a line between eleven and twelve miles in length. You can, perhaps, form some conception of the accuracy with which the work was done and the rapidity with which it was accomplished, when you know that the work was accomplished within a few

weeks; that the line was measured three separate times, and although more than eleven miles long, the greatest difference between any two of those three measurements was less than the thickness of my little finger, the measurement extending, as I have stated, a distance of between eleven and twelve miles. This, roughly speaking, is about one part in two million. That is, we have carried base line measurement to that degree of accuracy that the error is not greater certainly than one part in two million. Having measured the base line, the next thing is to extend that measurement through all parts of the country. If you will pardon me for making a very rough and small sketch upon the board, I will endeavor by it to explain to you the method of the extension of these triangles.

(Here the lecturer illustrated by means of diagrams upon the blackboard the methods above indicated.)

Continuing, Prof. Mendenhall said: This, in a very brief way, gives you an idea of the application of triangulation; and those who are perfectly familiar with it will pardon, I hope, my taking time to give this little sketch of it.

Now this primary triangulation is called primary because we make the greatest efforts to get the triangles of the longest possible size, and make the measurements with the greatest possible accuracy, so that systems of smaller triangles may be based upon this. In the first place with regard to the accuracy of the measurement; every school-boy knows that in any triangle, the sum of all the angles is equal to 180 degrees or two right angles. Now, these angles are all measured and of course they are measured a great many times. One station is occupied for several days and sometimes for several weeks, and all the angles are measured many times, these lines being many miles in length; but after it is all over, we have these three angles measured. Now, we add them together and of course this is a check on the whole operation. If they are greatly in excess of, or less than 180 degrees, a serious error has crept into the work. As a matter of fact, we do not accept any triangles unless the difference between the sum of the angles and 180 degrees is less than about six-tenths of one second. This will

give you some idea of the accuracy with which this triangular measurement is made.

Now, with regard to the length of the sides of these triangles, the object of taking a triangle with very long sides is economy, as it costs a good deal to occupy a station. Not very long ago, I had occasion to look at some of this work that is going on just now in Southern Indiana. A line of triangles has been started at about this point (indicating), and run across through southern Ohio and come up here to about where my finger is (indicating). Another series of triangles starts with the base at St. Louis, running east; this series begins at the Atlantic, and the next season's work will bring these two series of triangles together. Their stations are already intervisible. When the gap is closed, there will of course be much anxiety among these officers who have been engaged in the work, because there has been a base line measured at both ends and either one of these series of triangles will establish the position of the connecting points. Of course if the work has been thoroughly done, these positions will agree within a very small error; if they do not agree within a very small error, somebody is to blame.

Now, in running through southern Indiana, Ohio, and all this part of the country, it is necessary to use triangles that are comparatively small, sides of only ten, fifteen, twenty or thirty miles in length, because the country is usually so level. It strikes people often curiously that we have to use shorter sides in a level country. As a matter of fact, in a level country very high signals must be erected. The highest signal ever erected in this country was erected in Indiana, and is 156 feet high. This is rendered necessary in order to escape the general curvature of the earth, and therefore the sides of the triangles must be shorter. But when we get into the mountainous regions, we can do much better. We have now going on there some of the most gigantic operations in triangulation that have ever been carried on anywhere in the world. We have already triangles measured whose sides are 194 miles long. We occupy stations there eleven and twelve thousand feet above the level of the sea.

Another very interesting operation, and perhaps of more importance to most of you than anything I have referred to thus far, is the precise leveling across the continent. We have commenced a series of precise levels running from tide water here (indicating on chart), and running across the continent. A series of levels has also been run up here (indicating on chart), under the direction of the Coast Survey, and the Mississippi River Commission has also run a line of levels up the Mississippi River. By these two operations we have a check upon the work because an entirely independent corps has been engaged upon this work. Levels have been run through southern Ohio and have now extended across Indiana to St. Louis, and run up here (indicating on chart) in Missouri to Jeffersonville. Then we have some lines coming up here (indicating), branch lines or check lines, that have been worked out. The plan of the operation will be that these lines shall be carried clear across to the Atlantic; and then we shall have another system of lines running in an opposite direction so as to make checks upon the work.

This leveling is known in the Coast Survey as precise leveling. It would, perhaps, interest some of you if I could take a little more time describing the differences between this precise leveling and what is ordinarily called engineer leveling. I may say briefly in the first place, that it is all done in duplicate. Lines are run side by side, and then they are reversed and re-run, and a very small percentage of error is sufficient to oblige the leveler to go back and do his work over again. It is definitely fixed, the percentage of difference between these two duplicate levels. Then the instrument itself is different from the ordinary level which is used by the engineer in leveling. This precise leveling is of very great value to the country, and I am very glad, as I have already seen that many of you have been deeply interested in it. The object is to furnish at every important point a bench mark in which the exact height of that point above the level of the sea is given, so that the country may have several lines that have been determined with the very highest degree of accuracy, and to which ordinary railroad leveling and engineering and hydraulic

operations may refer. My only regret is that at present this is accessible to so few people. This single line of levels running across the country of course cannot be reached by very many people; but I believe that you will agree with me that it is of the utmost importance to extend that system. Already we have had demands for it down here in Missouri and Arkansas, and in several other places, and in fact we already have a line nearly completed up the Mississippi, which will be of great service when done. We want several more lines north and south, so that you will in the future have bench marks to refer to that will be of the highest degree of reliability.

A very interesting kind of work which the Coast Survey has been engaged in, is the gravitation work. I think you will all admit, without argument on my part, the importance of a knowledge of the shape of the earth. I will take it for granted that everybody admits that it is of the highest importance that we should know the real shape of the earth. This work consists of determining the force of gravitation at various points of the surface of the earth. That is done by means of the vibration of pendulums. The period of time in which the pendulum will vibrate depends on the length of the pendulum and also on the force of gravity. If the force of gravity increases, the pendulum will vibrate faster, and as the force of gravity decreases, the pendulum will vibrate slower. Suppose I take a pendulum, consisting of a small bar of metal, and swing it here until I find its exact period; then I carry it anywhere else and swing it there; if the force of gravity is just the same there as here, the period of the pendulum will be identical there with what it is here. If, however, it takes longer to swing, then I know the force of gravity is less; and if it takes a shorter time, I know it is greater. That is the statement of the problem in a very few words. And by ascertaining the force of gravity at these various points, by means of the pendulum, vibrating as I have shown you, we can get the real shape of the earth. A good deal of work has been done in connection with these operations. I have some maps that show the pendulum stations that have been occupied, but they have been mostly along the Eastern coast and down here

at Key West. Scarcely anything has been done west of the Allegheny Mountains. A station, however, has been occupied in Michigan. It is particularly desirable, indeed, that this pendulum work should be extended. There is a demand from our friends, the geologists, that our operations in this line shall extend all over this country. They say it is a matter of great theoretical interest to know whether the force of gravitation is in excess or whether it is in deficiency, and we have undertaken to comply with their request at the earliest possible moment. While this gravitation work is one of the most important and most interesting operations connected with the service, yet I need hardly say to you that it is one of the most difficult to explain to those who have little interest in this sort of work.

Another very important line of work we are doing and which is of interest to you, is the magnetic work. All surveyors and engineers are interested in this department of the work. It is, perhaps, a misfortune that we have to rely upon the magnetic needle for ascertaining our directions, but, nevertheless, that is a fact to a very great degree, hence the reliability of the magnetic needle as a direction indicator is a question of the highest importance. The Coast Survey has for many years endeavored to supply the demand along that line by furnishing to surveyors and engineers all the facts that could be gathered in connection with what we call the declination, or what is very frequently called the variation of the magnetic needle, together with all other magnetic facts, which would be of interest to surveyors and civil engineers.

In connection with that, I want to call your attention to two or three charts I have here (though I fear that not many of you can see them) representing some magnetic facts. I hope to interest you to such an extent that you will be willing to furnish us all the magnetic observations you may have in your possession or may make at any time, giving us carefully the observation and locality, and we in return will endeavor to repay you by furnishing you the result of the study and observations we make.

Here the lecturer explained the magnetic charts referred to, and afterwards continued as follows:

This map is the well known isogonic chart of the United States for 1890, the latest production we have. These lines (indicating) represent the declination of the needle. If the magnetic needle is located exactly on this line (indicating) it will point to the true pole; there is no declination during the year 1890. You will observe that line runs through the State of Ohio, a little bit east of Columbus; so that the variation or declination of the needle at this point ought to be, and as a matter of fact it is very small. For all along that line, throughout Ohio the declination of the needle will be zero, and along this line (indicating) it will point five degrees to the east, and here (indicating) ten, and here fifteen, and here twenty degrees, and over here it goes to the west five degrees, and here ten degrees, and here (indicating) fifteen degrees to the west. I have not time to discuss the matter at length, but only want to say that I have attempted interpolation on this chart with very great success. That is to say, on this chart the line for each degree is located, and you will notice in looking at Ohio that the city of Columbus, for instance, is between the zero line and the line of one degree; it is a little nearer the zero line than it is the line of one degree of declination. I therefore venture to predict, without knowing, that the declination here is probably from 22 to 25 minutes I presume there are several persons here who can tell me how near that may be to the truth. You will thus see it is possible to take this chart and interpolate your residence by means of it, and find very nearly correctly the declination of the needle at that point.

Then, here is another chart of very great interest, although I have not got on it all that we have on our printed chart. These show the zero lines historically back to a certain point; that is, they show the lines along which the needle points to the true pole. Going back to the date of 1797, the zero line at that time was here (indicating), running through Pennsylvania and down through Maryland; in fact, very nearly through the city of Washington. That is the farthest East it ever reached. Then it began changing in this direction, until in 1890, the present epoch, it is here (indicating). It is undoubtedly moving along in this direction (indicating) and we have evidence showing

that about the time of Columbus, or a little later, it was off in this direction (indicating). That is a very curious and thus far unexplained fact, that the line of no declination swings back and forth across the continent. Although we do not know the real laws which control it, yet we know its past history, and therefore know its future to a certain extent, and it is by reason of this knowledge we are able to predict those changes, and indicate them upon charts of that kind.

I will refer briefly to another chart, containing what are called magnetic meridians. These lines represent the course you would take, were you to follow the magnetic needle. Of course, as you go you would come into regions of different declination, but these lines represent the directions that you would actually take. The horizontal lines crossing this way, the dotted lines represent the dip of the needle, and the heavy lines represent the horizontal intensity of magnetism, a matter that has sprung into the highest importance in the last ten or eleven years (as was referred to last night by Prof. Thomas) on account of its application and use in all sorts of electrical measurements; that is, the horizontal component of the earth's magnetic force.

With regard to these magnetic charts, I wanted to say that there are four of them altogether. I have only referred to three, and the other is a chart of Alaska. They are published for the benefit of the general public. The difficulty is to get them into the hands of the people who would like to have them, and, if anybody here would like to have a set of these charts that have but recently been issued, all he needs to do is to address a note to the Superintendent of the Coast and Geodetic Survey, making the request, and the charts will be sent him.

Another thing that the Coast and Geodetic Survey has, in a sort of indirect way, long had to do with, is the matter of weights and measures. The earliest operations of the Coast Survey were of a unique character. I refer to those of the first superintendent, Mr. Hassler, a man brought over from Europe, possessed of the very highest talents, and particularly possessed of talents that just at that time were exceedingly

in this country, and therefore in very great demand. Mr. ssler was appointed first superintendent of the Coast and detic Survey. About the same time, some efforts were de looking to the establishment of a uniform system of ghts and measures throughout the country, and Mr. Hass- who knew more about weights and measures than any er member of the government service at that time, was appointed superintendent of weights and measures. From time to this the custom has been and is that the superndent of the Coast and Geodetic Survey shall also be erintendent of Weights and Measures. The two offices, e not legally connected, have always gone together, so at the present time the bureau or office of Weights and sures is a sub-office in the bureau of the Coast and Geo- Survey. The members of this Society, I hope, some of at least, have not forgotten that a few years ago I talked me length before the Society upon the subject of measures ngth, and of course I do not propose in anything I have y to-night to repeat what I then said, but I want to bring to date, and add the new facts we have developed since time, for I think you will be interested in this subject.

The two questions, perhaps, of the utmost importance to engineer—or rather the surveyor than the engineer, bee the engineer is obliged to take in some other questions reat importance—but the two questions of the utmost imtance to the surveyor, are the questions of direction and the tion of distance. Questions of direction are determined by use of the magnetic needle, or by means of astronomical rvations. I may say that I have necessarily to-night skip- over the question of astronomical operations of the Survey. determination of the latitude and the longitude go along h our other geodetic work. Besides the determination of ction, the surveyor must determine distance, and hence he terested in the unit of distance. The engineer goes far-; he is not only interested in the unit of distance, but also e unit of mass. He has a great deal to do with mass, the ntity of matter; so that, perhaps, to no body of men that ht be gathered together, would these questions of unit of

length and unit of mass be of more real importance than to a body of engineers and surveyors.

Suppose, then, you were to ask the question, What is the unit of length? Some would reply a foot, or a yard, the latter being really correct, the first being a derived unit. You might then ask what is a yard, or what is a foot? The childish way of answering the question would be that a yard is three feet, or a foot is twelve inches; but we are not better off when we have that answer than we were before. If required to state what an inch is, the answer would be that an inch is a twelfth of a foot, and that is a circle in which you would find yourself reasoning, the diameter of which would be too short to be safe.

Now, what is a foot, or what is a yard? I answered that question to some extent several years ago. I may briefly say, the answer to that question ought to have been, that our unit of length in the State of Ohio is the yard, and that unit is kept at the State House, and it was at one time at the State University. I am really unable to say whether it is at the University or at the State House at the present time. But there is a particular brass bar there, on which there are drawn two lines, separated a distance apart; and the State Legislature a good many years ago passed a law fixing that distance, between those two lines, as one yard. Now, I am very doubtful as to whether the State Legislature ever determined the temperature at which that should be one yard. I think it is very likely, if you look into it, you will find it did not, and if it did not fix the temperature at which it would be a yard, the State of Ohio has a very uncertain standard, for we all know that brass expands with an increase of temperature. In nearly all the States of the Union, these standards exist, and they were furnished by the Coast and Geodetic Survey nearly fifty years ago. They were furnished to the various States, and the States adopted them.

I want to remind you that the constitution of the United States says distinctly that Congress shall have the power to establish a system of weights, measures and coinage; and Congress has established a system of coinage, but it never has established a system of weights and measures. That is a very

important fact to remember, because you can go no farther for your standard than Columbus; you cannot go to the United States. Nearly all the States have adopted this standard; but some States have not. Within the last few months I have been investigating the question as thoroughly as I could, by getting information from the State Legislatures and State Sealers of Weights and Measures all over the country, with regard to the laws existing on the subject of weights and measures; and letters have been sent to foreign countries all over the world to ascertain what laws, if any, they have upon this subject. We are now accumulating a mass of information that is interesting and valuable. This has developed one very curious fact, and that is that some States to-day — I am not going to name them for fear that some people may want to go there to do business (laughter) — but there are some States to-day in which there are heavy penalties for selling or buying with false weights and measures, and yet which have never adopted a true weight or measure; that is, they have no standard weight and measure at all. If a man were to be arrested for using a false weight or a false measure in these States, the only ground upon which they could convict him would be by the recognized fact in law, that custom is law. Some States have really absolutely neglected to legislate on this question, assuming that the United States had legislated for them, but the United States has not. The standard yard of the Government of the United States is known as the Troughton scale. It is a very interesting old bar, made by Troughton in 1813, and brought over here in 1814. The bar is of brass, eighty-four inches long, two and one-half wide, and nearly a half inch thick; along through the center runs a thin strip of silver upon which the inches are graduated. By investigation, it was found these inches were somewhat irregular, but that the inches from the twenty-seventh to the sixty-third, that is, thirty-six in all, represented the average of all better than any other part of the bar; so Mr. Hassler adopted these thirty-six inches as the yard of the treasury department. Congress has never adopted that yard as the standard. In other words, it is a remarkable fact that the only standards of

length and mass that Congress has ever adopted for the whole country are the metre and kilogramme. The standard of mass is fixed in this country because Congress did enact that what is known as the Troy Mint Pound, should be the standard pound for purposes of coinage. It is in possession of the Mint at Philadelphia. It was copied by Kater—a name well known in science—from the original British Standard Troy Pound of 1758, which was afterwards destroyed by the burning of the House of Parliament in 1834. That pound was brought over to this country by Albert Galletin, and kept sealed in a box until brought to the city of Washington, where it was opened by John Quincy Adams, with considerable ceremony. At that time there was much interest felt in regard to this question of weights and measures, and great importance attached to it by these distinguished men. In fact, Adams said he believed his greatest claim to fame and reputation in the future would be the report which he made to Congress on the subject of weights and measures; and a most admirable document it was, going into the subject most thoroughly, and is in fact the fullest report on the subject ever published by any nation. This standard Troy pound is in possession of the Mint at Philadelphia, but is a very imperfect standard. I examined it a few weeks ago. It is shaped almost like a lemon, with the lower end made flat, and the upper end squeezed together to make a sort of handle.

Why is it a bad standard? Because it is unfortunately hollow. Kater, who described it very carefully, and described exactly how it was made, committed what to-day would be an unpardonable crime, in making the standard. He made it purposely hollow in order that he might make the final adjustment of its weight by dropping small pieces of wire into the hole, and screwing the cap on at the end. How easy it would be, if anybody at the mint were so disposed, to lessen the weight of that standard, and thus debase our coinage for a series of years! Of course it never has been done; and in fact the Troy Pound is a little heavier than it ought to be; so you are getting a little more in your gold and silver than the law provides for, but the amount, of course, is very small.

Recently, we have added to our collection of historic weights and measures in the city of Washington, in the office of weights and measures. There are, in its possession, certainly some very interesting things, which I wanted to speak to you about to-night. In the first place, I should like to speak briefly of a historic piece we have there, consisting of an iron bar, which is almost unique. I believe there are but one or two other copies of it in the world. It is known as the "committee metre," and it is interesting as actually antedating the real metre of the Archives. It was made by the French at the time of the French Revolution. There were fifteen iron bars made for inter-comparison, and after comparing those bars among each other, they finally made one out of platinum, which is the celebrated metre of the Archives. One of these iron bars was sent to the United States Government.

In 1866, the United States Government, as you are doubtless aware, made the use of the metric system permissible in the United States. That was virtually and indeed actually legalizing the metric system. And hence, as I say, the metric system of weights and measures, is really the only system of weights and measures that has ever been adopted or legalized by the United States Government.

About 1869 it became desirable to obtain from Paris the most accurate and precise standards for this system; that is, a standard metre and a standard kilogramme. Other nations followed the same course, and the result was that what is known as the International Bureau of Weights and Measures was organized, beginning its operations, perhaps, about 1872, but not reaching complete organization until about 1875. At first, sixteen of the most civilized and enlightened nations of the earth went into it. Perhaps I ought to correct that sentence, but I think I will let it stand; and by and by nine more, including England (laughter), came in. England, with all her conservatism, was not able to keep out of that International Bureau. She tried to do it for a long time, but she was finally obliged to come in; and those twenty-five nations combined in the construction of the new standards of length and mass — the new kilogramme and the new metre. I cannot describe in de-

tail the operations of this bureau; they are exceedingly interesting. They selected an alloy of platinum and iridium as the best material out of which to make the new metre and new kilogramme. Nearly fifteen years were spent in the construction of these new standards. Every device that could possibly be resorted to, was used to reach the very best ends. Studies of the best form of the metre bar in order that it might be free from flexure were made; studies of the best form of the unit of mass, the kilogramme, were made, and elaborate apparatus constructed. All of this, of course, cost a great deal of money, which was furnished by the various contributing governments, the United States contributing altogether up to this time to the International Bureau, about $40,000. On the 24th of last September, these standards were finished and ready for distribution to the various contributing governments. I may say, after these metres had been made, one was selected which agreed most nearly with the original metre of the Archives, and in fact the difference between that one and the original metre of the Archives is said to be zero. Now, it is a very rare thing for a scientific man to say that the difference between two things is zero. But what is meant by that in this case is that the difference is so small that none of our methods of measurement are sufficiently perfect to detect that difference. This is a remarkable fact, when I remind you that the original metre was an end measure, whereas the new metre is a line measure. As we all know, it is a difficult operation to compare the end measure and line measure; but this comparison has been made. All these metre bars have been compared with each other, and those in which there is a difference of three parts in one million, between them and the original, have been rejected, and were regraduated so they could have a very high degree of accuracy.

Finding that many people would be interested in these new standards, which are regarded as of the greatest value, and which, of course, it would be impossible to carry about, because they must be guarded with the very greatest care, I had prepared a model of the metre and also of the kilogramme, which I brought with me, and which I will show you, and then conclude by saying just a few words with regard to these

units. I had these models made in a way to imitate as exactly as possible the way in which these interesting standards came to us. That (indicating) is the way in which they were packed, only this tube, which you see here, differs from the original tube in the fact that the original is of heavy brass, while this is of tin.

Here the lecturer exhibited to the Society the models of the standard metre and kilogramme above referred to, describing in detail the manner of the packing of the original, and continued as follows:

These standards were brought over by one of the officers of the Coast and Geodetic Survey. They were sealed by the United States Minister at Paris; they were sealed by the International Bureau of Weights and Measures; they were sealed by Professor Davidson, who was the officer that brought them over; they were sealed by Dr. Gould, American delegate to the International Conference, and by almost everybody who had anything to do with them. The boxes were pretty thoroughly covered with seals, and a very careful history of every incident occurring in their journey was made. I have a little book containing the whole biographical sketch of these standards, which is very complete and interesting. If they were moved from one steamer to another, or if they were moved from one hotel to another, or from one train to another, the fact was noted, and a complete history of the entire journey from the time they left the International Bureau until they arrived in Washington has been prepared. And perhaps it may be of a little local interest to many of you for me to say that the next seal that went on them happened to be the seal of the Tyndall Association of Columbus, which I had in my possession (applause). Then, they remained covered by this seal and all the rest until the second day of January, on which day they were carried to the Cabinet Room of the White House, President Harrison having signified a very considerable interest in the matter, and a willingness to stand sponsor for the American public. There were present on this occasion the President of the United States, the Secretary of State, the Secretary of the Treasury — these were the official representa-

tives of the people, and there were the representatives of all the leading engineering societies of the country — the President of the American Association of Mechanical Engineers, the President of the American Society of Civil Engineers, the President of the American Institute of Mining Engineers, the President of the National Academy of Sciences, and others, representatives of the societies interested in weights and measures, were invited to be present on this occasion. Altogether there were thirty-five or forty people surrounding the table on which lay these boxes, covered with these seals. The President of the United States then examined the seals, and examined the official documents; and indeed, copies of these seals had been forwarded to the State Department. These were all carefully compared by the President, and afterwards he affixed his signature, as did also the Secretary of State and Secretary of the Treasury, to a document asserting that he had done all these things, and that these boxes were in the condition in which they purport to have been when they left the Bureau of Weights and Measures in Paris. Then, the boxes were opened and the standard metre and kilogramme were for the first time seen on this side of the water. They were examined, of course, with very considerable interest by these people, and after that they were packed up, and again placed under the seal to which I have referred, and under that they now rest. They will probably remain sealed in that condition for a long time. Standards of this character, of course, are such that we only rarely have occasion to refer to them. In England, the standard yard of Great Britain is sealed in the walls of the Parliament House. By act of Parliament, it can only be had access to once in twenty years. There are, of course, secondary standards, just as we have. We have three of those platinum metres, and to one of them we have, now, by the act of the President of the United States, given the highest authority; and it is my desire to have that also sealed in a way similar to that of the great yard of Great Britain, and only to be accessible once in fifteen or twenty years. And the other two will serve us as secondary standards for ordinary comparison.

There is much more I would be pleased to say upon this

subject, but my time is already exhausted. I want to say just a few words in conclusion. I would be glad to have any of you examine this model of the kilogramme and the metre to see the cross-sections, etc. As I said before, I desire to furnish you all the information possible with regard to magnetics, and I also desire to be of all possible assistance to you with regard to the units of measure and units of mass. If any of you, therefore, wish to have your units of measure, or units of length tested and compared, and to have upon them the Government stamp, giving their accuracy or their error, whatever the error may be, I should be very much pleased to have you send them to the Superintendent of the Coast and Geodetic Survey at Washington, when it will be done for a really nominal charge. We would also be glad to make comparison of weights whenever opportunity is offered. And in general, I want to emphasize the fact that the Coast and Geodetic Survey desires to put itself thoroughly and completely in touch with the engineering and surveying professions throughout the country; that it desires to furnish all of its material, and all of its publications that it can possibly furnish, to those into whose hands they ought to fall.

Just before I left home I had an examination made into the condition of the stock of the Coast Survey Reports. You are doubtless familiar with those large volumes that are published each year. We have several hundreds of each of the reports in stock, running back during the last ten years; and therefore I will undertake to send a set of those reports for the last ten years to any one who really wants them. Of course, I am not asking any of you to send for a set of those reports merely for the fun of having them come through the postoffice; but if anyone is really interested in the operations of the Coast and Geodetic Survey, and can find anything that is profitable to him in these reports, I will be very glad to supply him with a complete set as far as is possible. I may say that if any of you are connected with libraries of considerable importance, we can go a little back of ten years and furnish more copies than that. We cannot, unfortunately, supply a full set to anybody. There are one or two years exceedingly scarce; in fact,

altogether out of print. But we will do the best we can, and send sets at least running over the last ten years. We are issuing constantly supplements and appendices to these reports, giving the recent operations of the Survey, which will prove very interesting to surveyors and engineers.

I am very greatly indebted to the Chairman, and to the Society, for having listened so patiently to me. You have done so with such indulgence, that I am now going to trespass upon you to a very serious extent. The matter about which I am about to speak, hasn't anything to do with the United States Coast and Geodetic Survey. But the other day, Mr. Allen, Secretary of the Railway Publication Company in New York City, asked me if I knew anything about the condition of standard time in the State of Ohio. I told him I had known something about it in years past, much to my regret. He said then that he would send me a chart which would show all the times that were used in the State of Ohio. He is the great expert on that question, and I promised him when I came out to Ohio I would exhibit that chart, and therefore feel obliged, now, to exhibit it to you, without making any special comments upon it, because I really think that comment is not necessary. I may simply say that whereas a few years ago Ohio was the best time keeping State in the Nation, having but one single standard time throughout her whole boundary, to-day you have sixteen different kinds of time used within the State, and just how they are used and where they are used will be indicated by this chart, which any of you may examine, if you choose (applause).

DISCUSSION.

Mr. Varney: If anyone has any question to ask Professor Mendenhall, now is the time to do so.

A Member: I would like to ask what is the fee charged for examining a tape measure?

Professor Mendenhall: That depends, of course, on the degree of accuracy which is required in the examination. The

ordinary fee is fifty cents. When any extra degree of accuracy is asked for, of course the fee would be more; but I think the examination and test for which we charge a fee of fifty cents, secures a good degree of accuracy.

In answer to a question by a member, Professor Mendenhall said that the proper parties to address, in sending measures to be tested, is the Superintendent of the Coast and Geodetic Survey, Washington, D. C. Continuing, he said:

We are very willing and desirous to make these standards of length one hundred feet standards and put them in every State in the Union. For every State Government there should be a hundred foot standard, derived from the National Standard. The great advantage of that is that you can test your tape line much more frequently. You are aware, of course, that your tape lines constantly vary in length, and that more frequent comparisons are desirous, and if you had a standard here, you could make these comparisons more frequently than you will be able to make them if you have to send them to Washington every time.

A Member: I wish to ask if the Coast and Geodetic Survey recognizes standard time in any manner?

Professsor Mendenhall: Oh, yes; it scarcely recognizes anything else than so-called standard time. In fact, that is the case all over the country. It is a curious fact — you must not stir me up on the standard-time question (laughter) — but it is a curious fact that it is only when you strike Ohio that you find people who for some unknown reason are unable to use standard time. I saw a few weeks ago that the City Council of Cincinnati had adopted standard time, but I believe, as they say now, there was a "string" tied to the resolution, so that it did not go through, and we still find in the Cincinnati papers "local" time in use.

Mr. Pugh: A resolution was offered here about three years ago to adopt standard time, and it was referred to the Committee on Gravel Banks (laughter).

Professor Mendenhall: And was buried, I suppose.

A Member: At what degree of temperature do you usually make those tests?

Professor Mendenhall: At ordinary temperatures, but we do not care much about the temperature in tape line tests, because our standard is of iron, and is therefore essentially the same material as the tape.

Upon motion of Mr. Jennings, a vote of thanks was extended to Professor Mendenhall for his lecture.

Mr. Varney then called for Mr. Strawn's paper on "Water Works for Towns and Villages."

Mr. J. B. Strawn, of Salem, before reading his paper, said:

It is with a good deal of embarrassment that I find myself following my old friend, Dr. Mendenhall, a gentleman with whom I was once very intimately associated. It was with gratification and delight, on our part, that we learned of his promotion to the highest position in the United States, in the gift, I may say, of any Department of the Government. He stands first in that great work of the Coast and Geodetic Survey of the United States. My effort after his will be a good deal like offering to you, after you had been wined and dined on the choicest viands, bran bread and husks.

Mr. Strawn then read the following paper:

Water Works for Towns and Villages.

BY J. B. STRAWN.

Should we attempt a study of the many great enterprises, both public and private, which have for their object the advancement of mankind toward a higher civilization — which conduce to the general public good — those enterprises and institutions which have done most to promote health, comfort and longevity—which have done most for the protection of life and property, we should find that the introduction of Water Works for the supplying of the inhabitants of our cities, villages and towns with an abundance of safe, wholesome water for domestic purposes, and for the protection of property against fires and conflagrations, has accomplished more than all other improvements combined.

If we commence an investigation of this field of improvements by grouping the States of our Union, we should find that the New England States have taken the lead. Notwithstanding a small Water Works was built in Boston as early as 1652 by the "Water Works Company," we find that little advancement was made in this class of works outside a few of their larger cities until within a very short period, as we find that considerably more than half of their works have been built since 1880; and about one fourth of them within the past three years.

At present, New England possesses between 300 and 400 systems of works, with an aggregate cost of about $100,000,000, or an amount equal to $21.25 per head of total population.

Another interesting fact is brought out by a comparison of the mileage of water mains with the mileage of railroads in these States. In the Manual of Water Works for 1888 we find the water mains reported at 5291 miles; for the same year the railroads are reported 6684 miles. With the rapid growth of city improvements, doubtless the next decade will show the

mileage of water mains in this section in excess of their railroads.

No less interesting will be found the various sources of water supply, in the several States making up this group. Mainė draws her chief supply from rivers and large streams. Vermont and New Hampshire, mainly from springs which abound in those States. Massachusetts is supplied mainly from lakes and ponds. Connecticut's chief supply is surface water, while Rhode Island, though small in extent, is supplied principally from rivers and large streams.

In Massachusetts in 1888 there were reported 133 works; 87 of which were owned by the cities and towns, as public property. Practically every town in this State of over 4000 inhabitants has had enough enterprise and public spirit to build and own its works. The works built up by private capital were 55 in number, with an average population of 3470.

"Massachusetts shows its greatness and enterprise in nothing more conspicuously than in the public spirited way in which its towns and cities have taken hold of the work of supplying themselves with water at their own expense instead of waiting for private enterprise to do it for them."

The same is true of the State of Vermont. It has a smaller population per private Water Works than any other of this group of States.

The Water Works of the Middle States form a much larger interest than those of any other group of States. In this section there is an aggregate capital amounting to almost $160,000,000 invested in Water Works; and like New England, almost one-half of the works of this section have been built within the past seven years.

Turning to the Southern States, says a reporter: "If, as may fairly be claimed, the abundance of Water Works in a community is one of the truest tests of progress, the status of Water Works in the Southern States makes a most gratifying addition to the many proofs of the rapid progress of that section toward equality with all other sections in material prosperity."

Viewing the North Central States, which include Ohio,

Indiana, Illinois, Wisconsin and Michigan, we are no less surprised at the rapid advancement made in this line of improvements. Thirty years ago there were but ten Water Works in these five States. During the war period of '61 to '66, the only works built in this group of States was the insignificant plant put in in Salem, Ohio. The pump was a 6″ x 12″, or about an ordinary boiler feed pump. These works were rebuilt in 1887. Reported cost, $250,000. About 1871, the Water Works interest in this section received a "boom"; from 1871 to 1880, eighty works were built; from '81 to '85, there were seventy-eight added; from '85 to '88, one hundred and thirty-five more were built The year just closed will show a still greater number of Water Works for this section than that of any preceding year.

A glance at the far West will show that the pioneers and adventurers there have been no less active in the good work of supplying an abundance of water in the new cities and towns that have sprung up on our broad plains, and among our mountains which are giving forth their precious metals in response to the toilers, wielding the pick and pan, or, managing the mighty stamp as it crushes the sparkling quartz.

Taking the entire country as a whole, should we institute an inquiry into the *character* of the works which have been built within the past five years, we should find that a large majority of them have been for *towns* and *villages*, with varying populations from a few hundreds up to three thousand or four thousand inhabitants.

At present within the United States, there is not a city of any considerable size that has not its system of Water Works. Very few cities even of the second class are without works. There are *many*, and *good* reasons, which can be advanced for all cities to be thus provided. As we are not to discuss the importance of city works, we will at once turn to our subject, "**Water Works for Towns and Villages.**"

Here we may say with no less emphasis, that there are *hundreds* of beautiful thriving towns and villages in our country that are no less in need of Water Works than are our large cities. Many of our towns are suffering from a positively bad

supply of water; where, with a moderate outlay of money they might enjoy an abundant supply of good, wholesome water.

The great luxury furnished by an efficient system of Water Works, supplying an abundance of pure, delicious water, is a problem which many of our good towns shrink from undertaking to possess, or own, or manage.

The question may justly and legitimately be asked, *why should not all of our thriving towns and villages be supplied with the best water that it is possible to supply to its inhabitants?*

There seems to be no good, no valid argument, that can be urged against a town building and owning its own *Water Works.* There are, and always have been, objectors to public improvements—parties who are so constituted that they could not long exist if there was nothing for them to find fault with. They are born objectors, and the sooner a town is rid of them the better. The wheels of progress will roll more smoothly for their being out of the way. All improvements calculated to add to human comfort, health and happiness, are legitimate, and should be encouraged by all good citizens. There doubtless are many good, honest, fair-minded citizens who hesitate from a fear of making themselves appear conspicuous, but, are ready to make good *seconds* for any good cause.

We are fully aware that the great drawback to our much-needed improvements comes from a fear of failure, or, inability to successfully manage the financial part of the work. To meet this supposed inability to manage large work, some years since a scheme was devised by certain shrewd financiers and capitalists, to build works for towns and cities under franchise. The contract to run for twenty, thirty, and in some cases for fifty years, stipulating that the town, or city, should have the privilege of purchasing said works at the expiration of five years, or in ten years, or at any time after five years, as the contract might run. These companies are most all of them formed where money commands a low rate of interest. They tell you how much the works will cost, what they propose to furnish, and, will tell you what they will furnish a given number of fire hydrants for per piece, with water for public uses,

as sprinkling of streets, flushing sewers, for watering fountains, public buildings, drinking fountains, etc.

These franchises, in almost every instance, are granted without proper investigation, or a definite comprehension, or understanding of what the town is to get; much less, any carefully prepared plans and specifications or estimates. The town at the outset should know the cost, character of the works, size of the plant, quality and quantity of water, construction of reservoirs, or stand pipe, kind of pumping machinery, size and quality as well; kind of building for pumping station; kind and quality of fire hydrants and valves; in short, a full and complete set of plans and specifications should be required of the party proposing to build under a franchise, just as carefully prepared and considered as when works are to be built and owned by the town. All to be carried out under the supervision of a competent engineer. It must be remembered that the town from the first is the prospective purchaser. It should therefore know what kind of materials and workmanship are going into the plant.

Every town which contemplates putting in works should approach this problem carefully, prudently and intelligently.

Care should be taken to ascertain the real wants of the town. In this, should be considered the location and advantages, both natural and acquired, for growth of business enterprises — prospective population, based upon carefully prepared data — character and probable extent of manufactories. In this, ascertain the probable maximum quantity of water to be supplied for all purposes. This will lead to the determination of the size of pipes, machinery, etc — in fact, the dimensions of the entire plant. Having carefully considered and summarized the foregoing, the consideration of cost may now properly claim attention. In this, it may be necessary to outline a much more extensive plant than at the time can be carried out. But as the town should build not simply for the immediate present, but with a view of meeting future demands, its works should be so designed as to permit of extensions at any time, without having to rebuild, or reconstruct what has already been carried out in the general design. In this, it will possibly be

better to not attempt to cover too much territory at first; but to build what is done of heavier and larger dimensions than we would if the town had its growth, as some towns, by reason of their peculiar natural surroundings, have before constructing works.

Nor should a system of works be imposed upon a town, the cost of which shall be greater than the town can afford. An intelligent determination of this problem requires an examination into liabilities already incurred by the town, for any and all public improvements, claims and suits for damages against the town — the valuation of all real property as returned for assessment, rate of taxation, legal rate of interest, and the general financial standing of the town; with the apparent ability and willingness of the taxpayers to assume the payment of the necessary tax to meet all reasonable requirements in the building of works, such as have been under contemplation. Let me say here that the cost of works, other things being favorable, should not greatly exceed the legal rate of interest for money, based upon the whole valuation of property as returned by the appraiser of real property, and placed upon the tax duplicate. Putting the rate in Ohio at 8 per cent., being the maximum, it would be pretty safe for a town to build and own works, provided the entire cost did not exceed 8 per cent. of the valuation.

To illustrate — works were built in the town of Leetonia in 1889, costing, including real estate, engineering and incidentals, in round numbers, $41,000. The assessed valuation is about $680,000. This would make the cost equal to a trifle over 6 per cent. on the valuation.

As almost all of our towns, before constructing works or public improvements, go to the Legislature and secure an enabling act to issue bonds for procuring money with which to build, before contracting, should the amount asked for be much in excess of what would be realized on the basis indicated, the chances for satisfactorily placing their bonds would be quite doubtful. Parties handling bonds are unwilling to take risks without an increased consideration. It is always well to be on the safe side.

The question of ownership of Water Works has claimed much attention. There are many who claim that no town should own its own Water Works; that it is better to grant a franchise to some company building works on the franchise plan, than for a town to own its works. It is claimed that corporations in this kind of business can build and operate works more economically, and build better works for the money, than a town can.

This view is held by many towns, and even several of our large cities are now served by *companies*, instead of owning their works; and we may say greatly to their disadvantage. The cause for this condition of things has, in many instances, been brought about by falsely stating the costs of construction, maintenance, and running expenses of the works put in by private corporations.

So far as we have been able to investigate this subject, the cost of works built by franchise companies as compared with those built by towns, it would seem that the *towns* have been able to build much *more economically*, and, as a rule, better works than the generally reported cost and character of works built by "franchise companies." On this point we speak advisedly, having had experience with different Water Works companies building on the franchise plan, and in designing and superintending the construction of works which were owned and operated by cities and towns.

Now here is where many of our town authorities have been led astray. A franchise company building works for a village has everything practically their own way, especially the financial part. They will report fabulous sums of money paid out for various purposes, as *expert* services, *engineers* services, *attorneys* services, *superintendents* of construction, *foremen*, *bosses*, *secretaries*, *book-keepers*, sundries cut a very prominent figure, likewise incidentals, and a number of unheard of and unknown amounts which exist only in the imagination of the company, help to swell the grand total. One private company, of which the writer was one of the trustees, also one of the engineers, after all items had been gathered together, both real and imaginary, the president of the company proposed to add

$10,000 for service pipe, which had been laid from mains to curbs, which cost possibly $2000. These works are now reported at $250,000, which probably cost $125,000 in legitimate outlay. There were numerous blunders, unwise outlays, bad bargains, etc., which a town might, by prudence, have avoided. This amount put at six per cent. gives the astounding sum of $15,000 interest. Now comes in the computation on the other hand; for, the town can have their hydrant rental for $5000. No note is made of revenue received from private consumers. This item is kept in the back ground; and yet the books show a revenue amounting to the snug sum of $8000 + $5000 for hydrants = $13,000, less running expenses, $2000, leaving us $11,000 profits, or about nine per cent. on the investment, after paying all expenses.

Another town, putting in six miles of pipe, fifty-five hydrants, stand-pipe 20 by 80 feet high, taking water from a river, ordinary pump house, and pumps, report their works as costing $145,000. The actual cost was probably about $55,000. This also was by a "franchise company." We may speak with some degree of confidence concerning this plant, as the writer acted as engineer in the construction of these works. *The reported cost is false.* Is it any wonder that neighboring towns, wishing to have Water Works, should feel wholly unable to move in the matter, if these figures be correct? As stated, unfortunately in every town there are people who are so constituted that they can't help finding fault—ever ready to look upon the dark side of any problem, which has for its object the bettering of the human race. They are ready to give advice upon all subjects. Especially are they well skilled in telling how things should *not* be done. The most extravagant statements concerning costs and expenditures are magnified and distorted to such an extent that the engineer is almost persuaded to say as did Falstaff, "Lord, Lord, how this world is given to lying."

Having during the past season passed through with two Water Works systems, as designing engineer and superintendent of construction, a brief account of these works may not be out of place.

The first, and larger system of the two, was built for the village of Leetonia, Ohio. This village has a population of about thirty-five hundred; principal business, coal mining, iron manufacture, boiler works, tool works and American Porcelain Works.

The question of Water Works came up before the Council about a year and a half ago. Preliminary examinations and surveys were made, various sources of supply were examined, the probable wants of the town ascertained — springs and streams were measured, by placing weirs, and observations frequently made, water sheds traced out, and carefully examined, samples of water analyzed, locations for reservoirs and pump-house studied, pipe system outlined, hydrants and valves located. Options were taken on pieces of land, and lots, suitable for our wants. The source of supply determined upon was a collection of springs — the water, in the language of the chemist who analyzed the same, being "exceptionally pure and safe" — and the quantity seemed abundant for the wants of the town. Estimates were now made as to the probable cost of the works proper, viz: collecting water and conveying same to reservoir at pump-house, cost of reservoirs, pump-house, pipe system, incidentals, engineering, etc., which footed up to $40,443

This estimate was looked upon as being far below what works could be built for. Here was an opportunity for the objectors to enter the field. It was claimed that the works could not be built for *two* or *three* times that amount. An enabling act was procured from the Legislature, granting the town the right to bond itself for $50,000. Good men doubted the possibility of building a system, such as outlined, for any such money.

The matter of building Water Works was submitted to a vote of the citizens of Leetonia, and carried by an overwhelming majority — "Water Works, Yes."

The necessary plans and specifications were now drawn up, and time set for the opening of bids and letting contracts. The venders of pipes, hydrants, valves, pumps, and such articles as enter into the construction of a Water Works plant,

were on hand. One of the first rays of hope that penetrated the cloud which had confronted the engineer for months, came from an experienced contractor, when he said, "I will agree to build your Water Works according to the plans and specifications, in first-class manner, for *less than $50,000.*

At the opening of bids, five parties bid for the works as a whole. The average of the five bids was just thirty dollars above the estimates of the engineer. The *lowest* bid was taken for all of the work except the pumping machinery. For this, the largest machinery bid upon was selected, viz.: Two duplex compound engines of one million gallons each in *twenty-four hours*, and built by the Gordon Steam Pump Co.

The contractor furnished the Ludlow hydrant and Ludlow gate-valve, which were likewise the highest-priced hydrants and valves bid upon at the letting. Cast iron pipe, furnished by Cleveland Pipe Co., of New Philadelphia.

The specifications called for three reservoirs, to be built of *vitrified* fire brick, laid in cement mortar, viz: collecting, supply and storage reservoirs. These were circular, and of the following depths and capacities respectively: collecting, 8 feet deep, 10,000 gallons; supply at pump-house, 13 feet deep, 100,000; storage, 18 feet deep, 500,000; all three to be roofed. The pump-house, 28 x 52 feet, walls to be all hard brick, slate roof, ceiling of boiler room plastered. The engine room has a basement 6 ½ feet story, bottom cemented, with pump foundations built of hard fire brick laid in cement mortar. The four foundations for pumping engines start on a solid base of fire brick masonry 17½ x 12½ feet, and 13 inches thick, built upon a cement foundation.

The wainscoting and floor of the engine room are selected southern pine. The floor is surfaced and finished in oil; the wainscoting is finished in hard oil. The walls and ceiling are plastered and tastefully frescoed. The pumping engines are lagged in black walnut; the valve wheels are nickel plated, with the polished metal work of the machinery all combined, produces a very nice appearance.

The boiler room is paved with hard fire brick set on edge. There are two tubular boilers 54 inches in diameter, and 15 feet

long, with full fronts; Duplex boiler feed pump, Reynolds' heater, with all necessary valves, blow-offs, piping, etc. The coal room, which is located to be most convenient for the engineer, is 16 feet by 24 feet. The stack is 60 feet high, 7 feet square at base and 5 feet square at top. The walls of the stack are double; the inside walls, or flue, is built of fire brick; the outside walls are of hard red brick. No soft bricks were used in this job. The entire work of construction was carefully supervised from the beginning to the close of the work, and final acceptance of the same. There was no work that had to be torn out and rebuilt, or patched up; nor was there a single accident, blunder, break, or halt, from the beginning to the close. Throughout, the work was faithfully and honestly done, and of best material. The specifications called for *first-class* material and *skillful* workmanship, and nothing *less* than that called for in the specifications was permitted to be used. The utmost harmony existed between council, contractors and engineer. No suits for damages were left as a menace to the village.

The distribution or pipe system consisted of six miles of cast-iron pipe. The force main is 12-inch; the street mains are 10-inch, 8 inch, 6-inch and 4-inch. Care was taken to avoid as far as possible "dead ends." There are fifty-six double delivery fire hydrants, and fifty-one gate valves; service pipe, lead. There are three watering fountains for horses, and four public drinking fountains.

The water was analyzed by Prof. Francis C. Phillips, of Pittsburgh, Pa. "Mineral matter present, mainly carbonates of lime and magnesia, with very small quantity of chlorides and sulphates of sodium. * * * As to organic matter the water can be considered exceptionally pure and safe. Water of the character of the sample you sent is perfectly suitable for town supply.

REPORT OF ANALYSIS—GRAINS PER GALLON.

Total solids, 12.05 grains; hardness, 10.20 grains; hardness after boiling half hour, 4.10 grains; oxygen absorbed in

fifteen minutes, 0.042; free ammonia, 0.001; albuminoid ammonia, 0.005; nitrogen in nitrates, 0.05; nitrogen in nitrites, 0.00; chlorine, 0.20. FRANCIS C. PHILLIPS."

EAST PALESTINE WATER WORKS.

The village is within one mile of the line between Ohio and Pennsylvania, and on the Pittsburgh, Ft. Wayne and Chicago Railroad. Population 2000. Coal mining, sewer pipe works, pottery and carriage works are the leading industries.

Preliminary examinations for procuring a water supply were made in May, 1889. There are two good springs accessible, either of which was supposed to furnish ample water. The first lies above the town; water very hard, quantity insufficient. The second lies below the drainage of the town and quite close to an old cemetery, and still closer to the new cemetery. Water comparatively soft, quantity insufficient. Leslie's Run was next examined, the water shed studied, quality of water tested, etc. *Objectionable.* Slaughter-houses along the stream — drainage from several filthy swamps, and, if desirable, no suitable or available location for storage reservoir without great expense. This source was likewise abandoned. It was finally decided to put down a test well by drilling. This proving satisfactory, three other wells were put down, from which our supply is obtained. These wells are arranged so that others, if needed, may be put down and connected. For the present the quantity is all that could be desired, likewise the quality.

Samples of the water were sent to Prof. Otto Wuth, of Pittsburgh, for analysis, who pronounced the water of "superior quality." In concluding his report, he says: "For drinking, as well as for boilers, it would be difficult to find a better water."

REPORT OF ANALYSIS.

The sample of water contains in	10.000
Sulphate of Calcium	0.319
Chloride of Sodium	0.101
Carbonate of Calcium	0.630
Carbonate of Magnesium	0.223

Carbonate of Sodium.................. .... 2.606

It is almost absolutely free from organic matter.

OTTO WUTH, *Chemist.*

After practically settling the problem of our water supply, there remained other questions scarcely less important to be decided. In the meantime some preliminary calculations had been made, as well as an investigation of the all-important question of "*How much money can the town afford to spend on their works?*"

We next determined upon a location suitable for our reservoir for storage and "head." Fortunately this was an easy task. A beautiful knoll, quite convenient, and just the right height. In fact, if we had drawn up specifications to have one made to order, we could not have bettered what nature had done for us. The probabilities are that we should have forgotten to mention that the bottom should be of superior quality of fire clay, which we found when the excavation was made; which likewise furnished all our puddle.

We next figured out our pipe system, or distribution. When it came to determining what kind of pipe should be used, I felt like the old Dutch Squire, "my mind was made up," and I did not care to hear anything on the other side. But there *was* a good deal said. An agent for the "Wickoff Pipe" visited the town, and other pipe men came with their patents. All had the very best pipe that had ever been made; everybody now used their pipe. Committees were sent to various places to *see* what was *buried under ground.* As might have been expected of a committee who knew nothing whatever about pipe, they returned and unanimously adopted the pipe recommended by the engineer, viz: cast iron. After all, this sending of committees to visit towns, while it is a plain farce in most cases, yet it gives the abused, unpaid, self-sacrificing Councilman a chance to have an occasional good time at the expense of the town, who furnish the abuse as well as the money; and that is about all he gets.

Here is a town fairly well laid out for piping. The street mains are 10, 8, 6 and 4-inch, of cast-iron pipe, manufactured

by the Lake Shore Foundry, Cleveland, Ohio. Pipe laid 4′-6″ deep, or rather, have 4′-6″ cover. The pipe system measures 374 miles, with thirty-six Burbon compression hydrants, and twenty-eight stop valves.

The building for the pumping station is of hard brick, 28x40 feet; hipped slate roof, cornice of wood, neat ventilator on top of roof; brick stack 56 feet high, of hard brick; boiler room floor of hard fire brick, laid on edge in sand; engine room floor hard pine, laid on oak flooring crosswise; engine room walls plastered; both engine room and boiler room ceilings are of hard, or Georgia pine. Have one duplex high pressure pump, manufactured by the Gordon Steam Pump Co., of Hamilton, Ohio; capacity in twenty-four hours, 750,000 gallons; one steel tubular boiler, 14′x54″, with handsome front; with a Reynolds' heater and duplex feed pump, valves, blow-off, etc. The whole outfit is quite complete, for a small system. The reservoir, which has an elevation of one hundred and eighty-six feet above the railroad, (which is about on an average elevation of the town) or just twelve hundred feet above sea level; has a capacity of 300,000 gallons; the walls are circular and are built of vitrified fire brick, manufactured by the State Line Sewer Pipe Works, and laid in cement mortar. The reservoir has an octagonal roof of slate, with octagonal ventilator. The elevation of the reservoir will give very satisfactory pressure for domestic service; and at the same time, furnish ample fire protection, two valuable features for every Water Works system.

The matter of back filling of trenches possibly may have some interest connected with it. After the pipes were laid and thoroughly packed to top of pipe and around joints, the remainder of the dirt was returned by using scrapers. At Leetonia, a four-horse road machine was used; but as the machine could not be operated without changing to allow of working close to the trench, we had a long axle made of a round bar of iron about ten feet in length, with an iron brace to stiffen it. By this means, one of the wheels was permitted to run on the other side of the trench from where the dirt lay. This machine had a reversible scraper, which was of much

value in gathering the dirt farthest from the trench on the return trip. Our men in a short time became very handy with this machine. A team, with three men, in good dirt would do more filling than could be shoveled and packed by fifty men in the same time.

At East Palestine, the scrapers used were in form something like the old style dumping road scrapers, but were light, made about straight, and wider than the ordinary scraper. The dirt to be returned by this scraper must be thrown next the sidewalk, while with the wheel scraper it must be thrown on the side next the wagon road. The centres of pipe lines were located about sixteen feet (ordinarily) from the fence line, or about eight feet from curb lines.

While it has been exceptionally wet this past season, and, hence favorable for settlement of trenches, I seriously question if it pays to shovel and tamp trenches unless it be where there is extensive traffic. It is very difficult to pack dry earth so that it will not settle away when it becomes saturated with water.

The ramming, or *tamping* of dirt with horses, in trenches, will almost invariably cause the trench to arch over — will exclude the surface water, and not until freezing and thawing of the surface, will the trench become thoroughly settled. Now, if the dirt on top is left as loose as possible, the rains falling upon the street will, if the crown be of proper shape, be carried directly to the trench; and you all know the value of water for settling dirt in trenches.

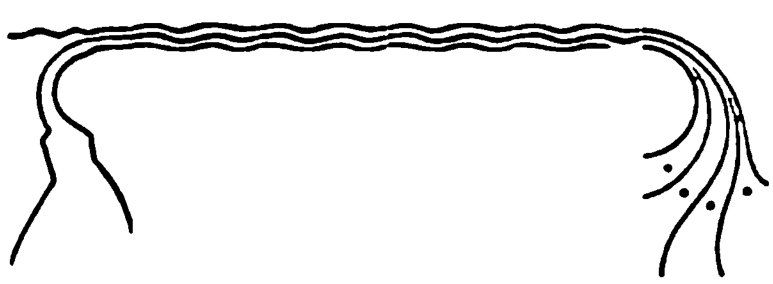
Should you examine the trench filling in Leetonia at present, you would find that wherever the dirt was returned by the road machine, there it is now practically all back, and some of the trenches will require extra dirt to fill them; while the trenches filled with shovels and rammed, are not so well settled, and in some places a considerable amount of surplus dirt had to be removed. A few trenches at first were filled by shovels and rammed.

The back-filling of trenches by means of scrapers is a great saving to contractors, and the trenches in the two cases cited

are certainly in better shape than they would have been by the ordinary method of filling and tamping.

The little system of works at East Palestine will cost the village about $23,500. The estimated cost was $23,000. Their appropriation is $25,000.

While there is nothing that is extraordinary or specially worthy of note in either of these systems, unless it be the *excellent quality of water* supplied, and the *remarkably small cost* at which they were built, yet they furnish examples of enterprise and public spirit which well might be followed by hundreds of other towns, that very much need a better water supply for domestic uses, and for fire protection — of which many of our towns are wholly destitute.



Rural Water Supply — Its Condition and Needs.

The reader may hesitate to enter a field in which the footprint of the sanitary engineer appears not. But untraveled and unmarked by surveyor as the way seemeth, yet the reader will attempt to explore so much as lies nearest recognized boundaries.

By Rural Water Supply the writer would be understood to mean the water used by the country people — the water used by small villages, hamlets and farming people.

THE OLD-TIME WAY.

When the writer was a boy, the country new, farms few and far between, the newcomer bought himself a piece of land, erected a log cabin and commenced the work of clearing up a farm. During the fall, winter and spring the adjacent brook afforded an abundance of water for both man and beast, though it was ofttimes highly colored by its leaching through the autumnal crop of leaves that covered the ground. As the summer months approached, the increased heat of the sun caused all surface moisture to take to itself wings and fly up to his warm embrace. The brook ceases to flow. The toil of clearing land to raise corn, potatoes, turnips, etc., is great, but water must be had. No water-witch with forked twig is consulted. The hole or depression in the brook that has furnished water of an increasing density till now forbids its longer use. It teems with life visible and probably life invisible.

The farmer, with hoe and fire-shovel (of spade luxury he knows nothing), cleans out the mud, deepens and widens the depression, throwing the excavated material all round, making a bowl-shaped top to the new spring or well, or whatever title it may deserve. Propitious heaven! While sweat stands in drops upon his honest brow to the joy of his heart, water oozes from the walls of the newly made excavation and fills the cavity. All the domestic animals and fowls scent afar the newly

acquired and priceless treasure — water, and hie away to the farmer's water supply. No Worthington, Holly or Corliss engine, with semi-omnipotent power, was there to pump up, with ponderous stroke, into its empounding trough the needed supply. A forked stick, from adjacent forest cut, and so adjusted as to serve as well sweep and sinker, and an old-time bucket of varied service, constituted the Water Works. Ere long the supply diminishes and the excavation is deepened. The continued use of this source of water supply, by travel of man, beast and fowl has worn out several depressed paths leading thereto.

In these depressions defecations accumulate, and when a rain-storm comes the water rushes adown these sloping channels with its burden of filth to this catch basin. And so it continued to the end of the chapter, while filth diseases in revelry perch themselves around.

But peradventure the newcomer actually dug a well, but walled it not with wood, brick or stone. The excavated material he throws around on all sides, greatly increasing its rain-catching capacity. Freezing, thawing, rain-storm and wash have greatly enlarged its mouth and decreased its depth and carried into it the fecal accumulations caught upon its funnel formed top until it has become the veriest of cesspools.

LATER ON, BUT NO BETTER.

The boy in question has older grown and stands ready to relate experiences of to-day. Let us take a case of every-day life. Pass out along one of our highly improved roads. There is a farm with a nice cottage house upon it with tidy out-buildings. There is a well lined with brick, capped with stone, and surmounted with a $20 iron force pump. Luxury! But hold! pig-sty odors greet your olfactories. You look around and there, within ten feet is the stock watering trough, and hard by, deep and wide, is the hog-wallow, in whose ample semi-fluid depth have basked in swinely glory many agone generations of hogs. Is this the only odor your sense of smell detects? Yonder upon that rise of ground is a nice barn, islanded in a lake

of semi-liquid manure. It may be fifty or more feet away. My readers may ask, How does that and the hog-wallow affect the well? Plain case. This same farmer will put in a tiled ditch four to five feet deep in his field and expect it to drain the water and dry his land 50 or 60 feet away. What is a well but an underground drain turned on end? Water, pure or filthy, in its subterranean passage moves in the direction of least resistance or pressure. To the well (the ditch turned on end) is that direction, and thither the filth-laden water passes from barn-yard, privy, pig-sty and wallow. The well in time becomes a dignified cesspool.

ORIGIN OF MILK-SICKNESS.

Take another example: There is a farm that exacts no admiration from the passer-by. In addition to part or all of what we found upon the farm first cited, we find the well curb a platform of sun-shrunk plank. Rats revel beneath it and ofttimes pay the penalty of their temerity by falling in the well and drowning. This rickety platform is ofttimes surmounted by a huge tub under the pump spout, filled with soiled linen, while the overflow carries this savory water to the well below. Chickens, geese, ducks and dogs swell the filth of the surroundings. Pass out on this farm to yon pasture. You reach a pool of ample dimensions for stock water. It is September. The water in the pool is low. The working up of mud by ingoing stock and their voidings have rendered this water supply filthy indeed. The farmer's cows drink of this water and his family use their milk. The cow, giving a good flow of milk each day, has immunity against disease, while nature bottles up in her milk the death-dealing disease, if it contains any. A cow giving milk liberally has immunity against milk-sickness, while disaster dire overtakes the calf and the user of her milk. We believe that stock drinking water, pure and wholesome, will not have milk-sickness or trembles, as it is called. This disease is probably a poisoning by arsenic. Any arsenic-bearing soil will produce it when the water is low. A case has never been known upon a limestone subsoil — a non-arsenic-

bearing soil. Readers, have you seen a well, a barn, a stock-pool in the condition above cited? Is not this a true picture?

Nine-tenths of all the diseases that afflict humanity are contracted directly or indirectly from the people's water supply. Go into our villages. Seek not the most tidy streets; on the contrary, let your explorations take in the alleys, the by-ways, the village dumping ground and skating rink — that catch-basin of the entire village water-shed. What are your findings? Have you praise for cleanliness, that virtue akin to godliness? There you see an assemblage of people. You draw near; you learn that funeral services are being held; you listen to the minister, who, with up-raised hands and eyes, deprecates the providence of God, who has removed by diphtheria or typhoid fever the loved one that lies cold in death before him. But the fact is, had cleanliness been observed the departed would have been hale and happy.

The minister, counterpart of his federal head, Adam, charges up, directly or indirectly, all the ills, to which humanity is heir, to his creator.

So varied, too, are the shadings of filth diseases that the physician is ofttimes perplexed to give them a name and devise a remedy. Paul, when he visited Athens, being of a contemplative mind, took a stroll among the public squares and places. In his strollings he passed an altar that had inscribed upon it: "To the unknown god." The Athenians, though they had gods many, were not disposed to withhold worship due to any. The smitings of conscience admonished them that there was a god unworshiped. They knew him not. That they might compass and appease him they erected an altar and inscribed upon it, "To the unknown god." So with the physician of to-day. These filth diseases baffle his skill, and to be sure to name them aright he calls them malaria. Now for the

NEEDS OF RURAL WATER SUPPLY.

Let your well be so constructed that not a drop of water can enter it until it finds its way through the overlying blue clay to within a foot or so of the bottom of the well. Instead of the stock pool above cited, have a good wind pump to pump

up pure water for your stock. Let no one say that even the least dainty of all animals, the hog, to say nothing of the cow, prefers foul, filthy water to pure. It is not true. As proof, if you have a water-yielding tile drain in your pasture, thither your stock goes for water. To obtain pure water, then, let all wells, everywhere, be either driven wells or be constructed something as follows: Dig your well three feet eight inches, or four feet in diameter. Go down until a good supply of water is reached; wall your well the first two or three feet with brick, drawing in and laying last course or two end to water, forming a circle twenty-four inches in diameter. Upon this last course set in a twenty-four inch sewer pipe, flange up, cover top of this pipe to keep out the dirt, and throw in the excavated material taken from the well and tamp it thoroughly around the pipe, like setting a post. When the top of this first pipe is reached, remove cover and set in a second pipe, spigot end down, in flange of first pipe. Fill space round between flange of first pipe and spigot end of second pipe with cement mortar made of best Portland cement, one part, and clean sharp sand, two parts; cover this second pipe that no dirt may enter well. Tamp earth around this second pipe as the first; so continue to the finish. Should the last pipe reach too high or not high enough, cut a pipe, using the flange end, and place it next the crowning pipe. Lay a brick wall all round the pipe, ends of brick to pipe, extending from about half inch above top of last into the ground not less than two feet, and all thoroughly embedded in cement mortar made as above. Spread over top of brick, say a half inch of cement mortar and surmont it with stone cap. Bacteria and microbes of disease, after sailing their tiny barks upon the subterranean seas until they reach such well water supply, are neither in number nor condition to wage a successful warfare upon humanity.

Natural Gas.

BY H. L. WEBER.

I will not endeavor to tell you all about this wonderful fluid, but will take up the theme, which treats of the method in which it is handled, statistics, and some of its advantages; so going to the point at once, "The Well." We will assume we have a gas well with a capacity ranging from three to thirty million feet per day. The first thing to be done is to shut it in; in some cases this is very difficult to do. Usually an excavation from three to ten feet square and the same in depth is made in which timber and concrete are placed to fasten the anchors to, and hold in the dry pipe. In this dry pipe is placed a pipe of smaller diameter, on the outside of which is a rubber "gasket," and by a system of right and left handed screws, the rubber is expanded and the well is shut in. On the inner pipe are all the necessary blow-off cocks and other arrangements to make attachments to the pipe line and to connect a "separator," which are being very extensively used and with good results in both the Ohio and Indiana fields. The Pertz & Stewart Automatic Well Separator, of Kokomo, Indiana, has proven a success. This separator is used to separate the water from the gas directly at the well, and prevents its accumu'ation in the pipe line. Should water accumulate, an automatic line drip is also placed at the necessary points. This completed, the well is connected to the pipe line, which varies in size according to the capacity or rock pressure of the well, and in a great many cases according to the size of pipe that can be obtained; and in this matter, in most cases, the engineer has very little figuring to do. The pipe used in conveying the gas from the wells to the plant are wrought iron or steel. And the telescope form are generally used *i. e.*, beginning at the wells (or field reducing station) with a smaller size and terminating with a larger.

The low pressure pipe in plants are in some cases cast,

as they are much cheaper, easier obtained, and answer the purpose practically as well.

At a convenient place in the field, and a point below all well connections, is placed a high pressure regulator. This is called the Field Reducing Station, and is used to reduce the rock pressure, which is the normal pressure under which the gas is stored in its natural reservoirs, (Professor Orton claims that the pressure which forces the gas out with such tremendous force is not due to the pressure of the gas itself, but to the hydrostatic pressure brought to bear by the column of salt water that enters the porous strata of rock containing the gas at the sea level, and which by its weight tends to force the gas out), and varies greatly in the different gas districts. The Trenton in Ohio shows about 400 pounds; Indiana, 325; while in Pennsylvania the rock pressure has a wide range, from 200 to 1000 pounds to the square inch; but in general it ranges from 200 to 500 pounds. The high pressure regulators reduce the pressure to any desired number of pounds. Usually on the main a pressure of from 120 to 300 pounds is carried to the reducing station at the city limits or plants where it again goes through a reducing process. This time from 120 pounds to about 25 pounds for the high pressure line through the city. From these high pressure lines it enters a low pressure regulator and is again reduced from 25 pounds to the square inch to about 5 to 7 ounces to the low pressure line, and from these lines you receive your gas for heating purposes. The Natural Gas Companies take the gas to the curb, and from this point the consumer pays for the piping to the point consumed, in which case it may be a grate, stove, or furnace. Before entering the stove, a mixer is placed on the pipe in size according to the requirements of the case, for which you pay according to the rules of the company which are generally regulated by ordinances by the City or Village Council.

I think it very wise for consumers to have placed on their services the house regulator with the automatic cut-off attachment, as the gas might fail in the night or be thoughtlessly turned off, permitting the house fires to go out, with the valve open, and then if turned on again houses and furnaces would

fill with gas, and might cause an expensive explosion. The old adage that an ounce of prevention is worth a pound of cure, should always be uppermost in one's mind when handling natural gas.

The discovery of natural gas is not recent. Possibly the first well bored for natural gas was at Fredonia, N. Y. In 18[illegible], when Lafayette visited this country, the village inn was illuminated in his honor by gas from this well. But devices for handling natural gas are recent, and many a city revolutionized in the manner of heating and manufacturing, which when properly entered will be placed largely to the credit of the civil engineers of to-day.

"As to the origin of natural gas, scientists generally agree that it arises from decomposition of forms of animal or vegetable life imbedded in the rocks in suitable situations. It is not believed to be generated continuously, but merely to be stored in porous or cavernous rocks overlaid by impervious stratas, when these rocks are tapped the gas is set free, but a new supply is not being formed to take its place."

The chemical composition of natural gas from one well differs from gas from another well, and even the gas from the same well varies in its chemical composition continually. Gas taken from the same well was found to vary in nitrogen from .23 per cent. to 0 per cent.; in carbonic acid from 2 to 0 per cent. and in oxygen from 4 to 0.4 per cent. The average of six samples from the same well gives the following analysis by volume:

Marsh Gas	67.00
Hydrogen	22.00
Ethylic Hydride	5.00
Olefiant Gas	1.00
Oxygen	.80
Carbonic Oxide	.60
Carbonic Acid	.60
Nitrogen	3 00
	100.00

The specific gravity of natural gas is about .52 or a little more than one-half the weight of air.

The theoretical value of natural gas as a fuel, compared with coal, is about as follows: 1000 cubic feet of gas equals that of 54.4 pounds of bituminous coal, or a practical equivalent of 30,000 cubic feet of gas to one ton of coal.

Natural gas if mixed with air in a close vessel in the proportions of 8 to 15 volumes of air to one of gas, and ignited, an explosion of more or less violence will result; with less than 8 or more than 15 volumes no explosion will occur, and the most violent explosion will occur with a mixture of 10 or 12 parts air to 1 of gas.

Natural gas is found in commercial quantities in Ohio in Trenton limestone in the Mercer and Wood County field, at Thurston and Lancaster in Clinton limestone, at an average depth from the surface of 1250 feet; in Indiana in Trenton limestone, Niagara limestone, Devonian shale and limestone, and Hudson River shale, at depths from 700 to 1000 feet from the surface.

In Pennsylvania, gas is found in sandstone rock at a depth ranging from 500 to 3000 feet from the surface, according to geological position and surface elevation.

The production of gas wells in Ohio and Indiana fields ranges from 300,000 to 15,000,000 cubic feet per day. The last well in the Wood County field, which is owned by the Northwestern Natural Gas Company, shows a capacity of 43,000,000, and is claimed to be the largest well in the world; while those in Westmoreland County, Pa., average from 10,000,000 to 12,000,000 cubic feet; the Howard well by measurement produced 30,211,000, and many wells of 20 to 25,000,000 have been obtained in the Western Pennsylvania gas fields.

Natural gas has many advantages; if "cleanliness is next to godliness" it is a good thing for the consumer morally, an advantage a coal stove with forty feet of old pipe does not possess. Cleanliness of the person and house is another blessing secured by substituting gas for coal; no dust attends upon a gas fire; the curtains, carpets, wall paper and other decorations are unsoiled when gas is properly used, resulting in a great saving in washing, in wear and tear, and renewals. Uniformity in temperature may be perfectly secured, which is

another very important advantage, insuring freedom from colds and from other complaints due to alternation of heat and cold. Another great advantage (to the over worked and tired engineer) upon returning home in the evening after a hard day's work, he does not hear the one he loves best call out, John split some wood and kindling, or heave up a bucket of coal from the northeast corner of a damp and dusty cellar. This is all done away with; no ashes to cart away, or ash leaches to set up, but instead, supper is in waiting and your better half or sweetheart is singing praises to your wonderful ability for devising plans by which natural gas can be so successfully utilized, giving one as much or as little, when and where they want it, by the striking of a match, and by the single twist of the wrist the valve is turned, you have it. In hot and cold weather it has its advantages over every other fuel.

City Streets—How to Build Them, and Why.

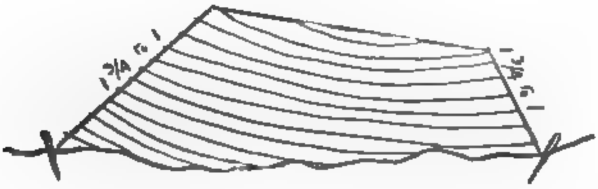
BY MR. L. W. MATHEWSON.

In presenting to this Society a talk on the hackneyed subject of Street Construction, we do not conceive that we shall be able to present anything really new, although it is possible that we may strike upon a few points that may be new to some. And, that we may more fully understand each other, I will say in the beginning that we speak more particularly of work as conducted in and about Cincinnati, having had but slight experience elsewhere.

The general points which apply to streets of every class, are the excavation and embankment, drainage, and setting curbs, gutter flags, and crossing stones.

In excavation, we make no distinction between sand, gravel, loose earth, hard pan or rock, leaving the contractor to form his own judgment as to the material to be handled. This closes the door upon a long series of petty annoyances arising from the attempt to classify and measure the various kinds of material. The contractor is free to handle his cuts in any way he chooses, the only requirement being that such slope shall be given to the banks as will prevent the obstruction of sidewalks by material slipping from the banks. Such slope is generally 1 to 1, but may be from ½ to 1 to 3 to 1.

In embankment, the contractor is required to begin the fill at the slope stakes, (which we usually set for slope of

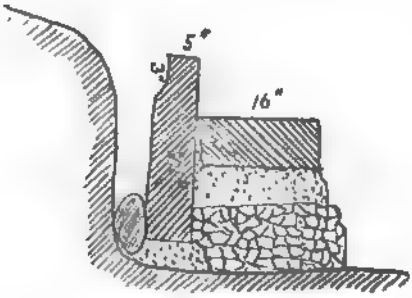


1¾ to 1) and fill in 9″ layers, keeping the outside at least one foot higher than the centre, as shown in the sketch. The

main point to be observed in securing the regular and uniform consolidation of the embankment, is to carefully regulate the movement of scrapers, carts or wagons, so as to prevent them following each other in procession, thus forming deep ruts and to compel teams to travel equally over all parts of the embankment, so that it may be uniformly compacted.

The drainage of streets might well form the subject of a separate paper, beginning with the formation of the gutters and passing to the laying of underdrains, construction of box culverts of wood or stone, circular culverts of brick, stone or sewer-pipe, sewers, large culverts and even small bridges might properly come under this head. The crown or height of centre of roadway above the gutters should be: for macadam, not less than ¾ of an inch per foot; for bowlders, ½ inch to ⅝ of an inch per foot; for granite blocks, ½ an inch per foot; for brick or asphalt, ⅜ to ½ an inch per foot. For underdrainage of bowlder streets we depend mainly upon a bed of broken stone, 12 inches or more in depth. While we have great faith in tiles where they can be used with safety, the ruthless hand of the gas and water works fiend has long since taught us the folly of such devices in city streets. Yet there are cases where the presence of springs either in the street itself, or in the hillside above, make it necessary to resort to them.

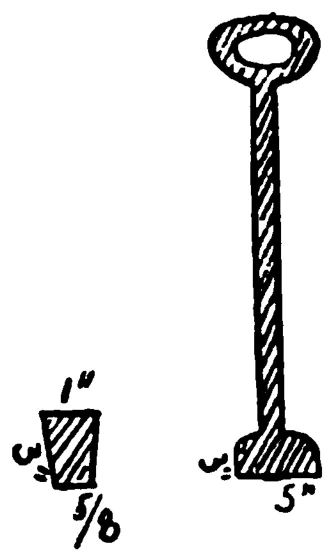
Curbs are 4 to 5 inches thick, dressed 10 inches on the ends, 12 inches on the face and 3 inches on the back; not less than 21 inches deep and 3 feet long, with a bearing on the bottom of not less than ⅞ of the top length, and are set on 2



inches of packed sand or gravel. When set, the sidewalk tends constantly to press the top of the curb outwardly over the

utter. To cure this we require that stones be placed·back of ch curb at the bottom of each end of each curb, so as to mpletely fill the space between the lower part of the curb d the bank, as shown in sketch on page 96, and thus pre- nt the curb from swinging on the upper edge of the gutter g. As an additional preventive the curb should be set with batter of about 1¼ inches, forming a right angle with the itter flag. When so placed, the appearance of the curb and e drainage from the sidewalk will be assisted by cutting the p of the curb to a bevel that will conform to the slope of e sidewalk.

To further secure the curb it is necessary that the back ling be thoroughly rammed. For this purpose a tamping



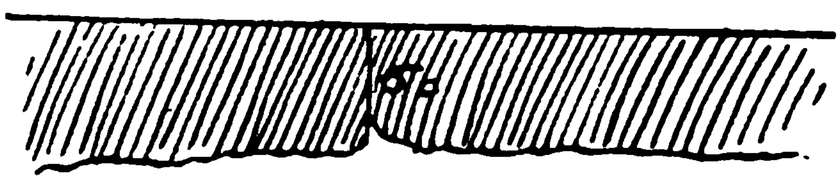
n, made as shown by figure, will be found both useful and nvenient. Gravel or sand should be used as the material for ck filling.

Many cases occur where there are angles in the street lines, d also many intersecting streets coming in at various angles. e tangents are connected by circular curbs dressed to 6 feet dius for intersecting streets and to special radii for street gles. In such cases a special plat is prepared for the con- ctor and the quarryman, showing the exact length and radius which each circular curb must be dressed. Each curve is signated by a certain letter, and the stone for the curve when t is marked with the same letter. When brought upon the eet each stone can then be dropped at the proper place.

Gutter Flags are not less than 3 feet long, 6 inches thick d 16 inches wide, cut on one side to fit snugly against the rb, top hammer dressed, and the ends dressed and squared to

make a ¼ inch joint for the depth of 3 inches from the top. The foundation should be thoroughly rammed and the flag set upon a 6 inch bed of gravel. The ordinary depth of gutters is 7 inches, but this is varied according to circumstances.

Crossing stones should not be less than 5 feet long, 16 to 18 inches wide, and 6 inches thick, hammer dressed on the top, ends dressed and squared so as to form a ¼ inch joint to *full depth of* 6 *inches*. This is *the* important point in maintaining a good crossing. Usually through defective joints a small gap is opened between the stones into which each successive vehicle falls with increasing force until the stone is destroyed. This is nearly always caused by setting them with a "feather-edge."



From the sketch it is readily seen that a very slight blow will start the work of destruction. But when squared so as to form a good 6 inch joint, the useful life of the crossing is enormously increased.

The streets most common in Cincinnati are or have been the macadam, bowlder, Nicholson block, locust block, granite and asphalt, to which, we believe, is now to be added pavements of brick.

Macadam streets as ordinarily constructed, consist of two layers of broken stone. The sub-grade is first brought to a depth of 14 inches below the roadway grade. Stone broken to size not larger than 6 inches, are placed upon the street about 20 inches deep. This is thoroughly compacted with a steam road roller, and after rolling, the layer is about 8 inches deep. A second layer of stone broken to 2½-inch size is put on about 7 inches deep, and this again is thoroughly compacted by rolling, which reduces it to 6 inches. A two inch layer of gravel is then spread upon the surface of the broken stone, but not

rolled. A very important point in connection with the upper layer is to have the stone as free from clay as possible. Dirt in the interstices retains moisture, and causes the surface to wear with much greater rapidity than if clean and dry. Another important point is to have the stone *thoroughly* broken to a a size not greater than *2½ inches* in longest diameter. When so broken the stone will, when compacted, form a smooth surface which it is not possible to obtain with large stone.

Very little can be said in favor of our macadam roads. They are easily built without skilled labor, give firm foothold, and are readily torn up and repaired; but when subject to heavy traffic their usual condition is to be covered with blinding and stifling limestone dust in dry weather, and a sea of mud in wet weather. The rapidity with which they wear out, and the excessive expense of repairs, running often to 40 cents per square yard per annum, makes this a class of construction to be avoided where possible. Consequently they are used almost exclusively on suburban streets, where there are large tracts of unimproved property, and where any valuable pavement would be utterly destroyed by the ripping up necessary to put down water, gas and sewer pipes with their connections to each lot as buildings are erected.

Thus much had we jotted down on the subject of macadam roads, believing that at least a small part of the wisdom of the past and present age was garnered in the preceding lines, when we were somewhat astonished by the following advice administered by an *Able Editor* to a young and thriving city of the far West:

"It is to be hoped that when beginning the work the people of D—— will have the luck to ascertain at once that the *best pavement* in the world is not the *asphalt* or the *granite*, but a *macadam*." Then he describes how to build the "best pavement in the world" as follows: "Beginning with a good foundation * * * there should be thrown upon it 8 or 9 inches of hard stone, broken fine, * * * and upon that a liberal coating of *concrete* should be *rolled* to make the road solid. The fine points of the broken stone will penetrate the concrete just enough to give a good footing, and the result is the pavement

endures as if it were *the everlasting rock itself.*" In another article he emphasizes the above by saying that "on a good foundation of gravel crushed bowlders should be laid to the depth of 9 inches, and upon the bowlders *abundant concrete* thin enough to penetrate the fine stone." Now I suppose that this Able Editor really means, not concrete, but cement mortar or grout. If any rolling is done after the grout is poured on it must be done *very rapidly* and over small spaces. If the grout has time to set, the rolling would break it and destroy its usefulness. He further adds "there are a few such pavements in London, the best the city contains."

Where bowlders or granite, broken to 1½ inch size, can be obtained for surfacing roadways, it will make a firm, smooth roadway with which our hill limestone will bear no comparison. Where not subject to disturbance by excavations for water, gas or sewers, all macadam roads should be underdrained by a line of good, large tile on each side of the roadway, unless naturally underdrained. Their cost will be saved many times over by the decreased wear of the metal. Where gravel is abundant and cheap, a great saving will be made by putting it on to the depth of six to eight inches, for lower course, and reducing the depth of the broken stone by the same amount.

BOWLDER PAVEMENT.

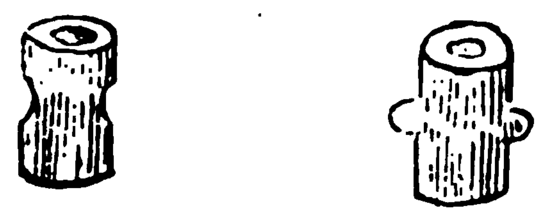
Bowldered streets are constructed as shown on the drawings on pages 112 to 115. An examination of these will explain their structure more clearly than words. The gravel should not be too sharp, but should have about 15 per cent. of loam, and good cementing qualities; otherwise it will not form a bond with the bowlders. These should not be larger than eight inches, nor less than four inches in longest diameter. If larger, the pavement is very rough. If smaller, the bowlder will not remain in place. They are set small end down, and as *close together as possible.* The reverse of this rule we find to be the guide with many pavers, with the idea no doubt that the more quickly the pavement is broken up, the better the chances for another job.

Not much can be said in favor of the bowlder pavement.

he cost is moderate, and the bowlders seem to be everlasting; ut the gravel bed works up through the pavement and is arted off to the city dumps. At best, it is rough and noisy, nd easily worn into ruts and holes. It is hard to clean, and n fact, must be kept partially covered with a coat of gravel r dirt to drown the noise and jar of vehicles. Where street ailroad tracks are laid, the constant jarring of the rails throws ut the bowlders. Granite blocks laid alternately parallel to nd at right angles to the rails, materially assist in retaining he bowlders in place.

NICHOLSON BLOCK.

Shortly after the close of the rebellion, a furore arose for icholson block paving. Millions were wasted. It has had s day, and is now a relic of the past. At this day it seems ery remarkable that anyone should or could entertain the elief that the wooden blocks should be anything else than a mporary pavement, absorbing the filth and nastiness falling pon its surface and quickly decaying As illustrating the ueer ideas some persons entertain, about the time the wooden lock pavement had thoroughly demonstrated its worthless-ess, a most elegant gentleman, all the way from Boston, pre-ented himself at our office to exhibit some round blocks,



urned as in the sketch, with the idea of fitting them together nd preventing the blocks being thrown out. Such a pave-ent would be *very costly*, and as no trouble of this kind had isen, the gentleman was certainly wasting his energies to ttle purpose.

Another candidate for public favor patented this month anuary, 1890), consist of wooden blocks 2½ inches square on p and 5 inches high, set in small iron compartments, cast on an iron plate. The weight of the iron is about 180 lbs.

per square yard, which at two cents, would be $3.60 per yard. The great expense of cutting each block to fit exactly in the compartment would increase the cost to nearly double that of asphalt or granite. Notwithstanding that the wooden block has been almost entirely abandoned in this country, the singular fact appears that in Europe, notably in London, Paris and Berlin, granite and asphalt are used extensively. These are probably prepared with some preservative to increase their durability and to prevent the absorption of street filth. So far as I can ascertain this has not been attempted in this country, except on a very small scale, for the reason that the application of creosote or other preservative increased the expense beyond the cost of a more perfect pavement.

LOCUST BLOCK.

The locust block, introduced about 1870, is likewise a relic of departed wisdom. This had some good qualities, but the test of time and travel proved that in a few years the blocks wore off on the outer edge, leaving a large, round, slippery knob, very injurious to horses.

GRANITE BLOCK.

The drawings show the method of constructing granite block pavement with double street railway tracks. When the road-bed is graded to true sub-grade, it is thoroughly rolled with steam road-roller. All soft or spongy places are excavated and the holes filled with broken stone, and again rolled. For the concrete, take one part of cement and two parts of clean, sharp sand, thoroughly mixed dry; make into a mortar with the least possible amount of water; about five parts of broken stone are then thoroughly and rapidly mixed with the mortar. When spread, the concrete is thoroughly compacted by ramming until free mortar appears upon the surface The upper surface of the concrete is made exactly parallel with the roadway surface, and covered with two inches of fine sharp sand.

The granite blocks are set directly upon or imbedded in

the sand with close end and side joints *not exceeding three-fourths of an inch.* This is one of the most important points if the work is to be enduring; wide joints give a play for toe corks and wheels which soon destroy the pavement. The dimensions of blocks are 8 to 12 inches in length, 3 to 4½ in thickness and 6 to 7 in depth. They should have a fair and true surface on top, sides and ends, and should not vary more than one-half inch from rectangular shape. They should be of uniform grain and texture, without lamination or stratification, and free from mica or feldspar. They should be tough and durable, not so hard as to polish or so soft as to crumble under traffic. When set the blocks are covered with small hot pebbles one-fourth to five-eighths of an inch in diameter, and broomed in until the joints are thoroughly filled; the pebbles are then raked out to the depth of about one inch, and paving cement heated to 300° Fahrenheit is poured into the joints until they overflow. This requires about 3 gallons to the square yard. In some cities the pebbles and paving cement are omitted, and clean, sharp, granular sand used instead. It is claimed that this is equally effective in binding the pavement, is durable, and will not rot out like the paving cement. Where such pavements have been torn up, the discoloration of the sand was found to extend only 2 or 3 inches below the surface, showing that the joints are practically water-proof. This will diminish the cost about 30 cents per square yard, and for the granite paving now laid in Cincinnati would have saved over $200,000. This point is therefore well worthy of careful examination by any corporation proposing to lay granite blocks.

Our experience with granite is sufficient to demonstrate that it is far from the perfect pavement which all municipalities are seeking. It is very costly—about $25.00 per running foot upon Cincinnati streets. It is very noisy and hard on horses and wagons. First class experts in granite are required to select stone of the proper quality, and skilled labor is necessary in putting it down. Aside from their ability to retain their places, and the facility for cleaning, the granite blocks are very little improvement over bowlders.

ASPHALT PAVING.

Asphalt paving consists of two distinct classes.

1. The asphalt proper, as now used by the Warren-Scharf and the Barber Paving Companies and obtained from the island of Trinidad.

2. The bituminous rock as laid extensively in California and now coming into use in the Eastern States.

The Trinidad asphalt in its natural state is too brittle to be used for paving purposes, and must be mixed with other materials to give it the tough and elastic qualities so necessary to its durability. The specifications under which it is laid are as follows:

"The following materials compose the wearing surface: 1. Refined Trinidad asphalt. 2. Heavy petroleum oil. 3. Fine sand containing not more than 5 per cent. of hydrosilicate of aluminum. 4. Powdered limestone. The Trinidad asphalt as found in this market contains from 20 to 35 per cent. of impurities, and must be refined and brought to a uniform standard of purity and gravity. The heavy petroleum oil generally contains water, light oils, coke and a gummy substance soluble in water; the petroleum oil is freed from all impurities and brought to a specific gravity of from 18° to 22° Beaume, and a fire test of 250° Fahrenheit. By melting and mixing petroleum oil 20 parts and asphalt 100 parts, the matrix of the pavement, called asphaltic cement, is formed, which cement must have a fire test of 250° Fahrenheit, a temperature of 60° and a specific gravity of 1.19.

The pavement mixture is formed of the

Asphalt cement.............	15 to 18 parts.
Sand	70 to 65 parts.
Powdered limestone.........	15 to 17 parts.
	100 100

In order to make the pavement homogeneous, the proportion of the asphaltic cement must be varied according to the character and quality of the sand. The sand and asphaltic cement are heated separately to about 300° Fahrenheit. The powdered limestone while cold is mixed with the hot sand in

the required proportions, and is then mixed with the asphaltic cement at the required temperature and in the proper proportion in a large box, where agitators are constantly revolving, and a complete mechanical mixture is formed.

The pavement mixture prepared in the manner thus indicated is laid on the foundation in two coats. The first coat, called the cushion coat, will contain from 2 to 4 per cent. more asphaltic cement than given above. It will be laid to such depth as will give a thickness of one-half inch after consolidation with a roller. The second coat, called surface coat, prepared as above specified, will be laid on the cushion coat. It will be brought to the ground in carts at a temperature of about 250°. It will then be carefully spread by means of hot iron rakes, in such manner as to give a uniform and regular grade, and to such depth that after having received its ultimate compression of two-fifths, it will have a thickness of two inches This surface is then compressed by hand-rollers, after which a small amount of hydraulic cement is swept over it, and it is then thoroughly compressed by a steam roller, weighing not less than two hundred and fifty pounds to the inch run, the rolling being continued for not less than five hours for every one thousand yards of surface.

The powdered limestone will be of such a degree of fineness that 16 per cent. by weight of the entire mixture shall be an impalpable powder of limestone and the whole of it will pass through a No. 26 screen. The sand will be of such size that none of it will pass through a No. 80 screen, and the whole of it will pass a No. 20 screen."

The gutters for asphalt streets may be formed of granite blocks, special hard-burned paving brick, or still better, of the regular granite or flat rock gutter flagging. The necessity for some other material than asphalt for the gutters has been fully demonstrated, as moisture causes it to rot.

These specifications are the result of a series of costly and exhaustive experiments, and are no doubt as nearly perfect as human ingenuity can make them. In Berlin it has been lately discovered that gas escaping from the gas mains will disintegrate the asphalt, and it is probable that this may account for some of the mysterious failures of asphalt in Cincinnati.

At first it was believed that asphalt would not give good foothold, but experience has proven that if laid with proper crown of not more than three-eighths of an inch per foot it is as safe as stone or wood. It is beyond question the acme of a perfect pavement except as to cost and durability. The objections are that it requires a special plant and skilled workmen to handle it. Companies or individuals cannot afford to maintain these except in cities where large quantities are laid. With the utmost care and skill in its preparation failures will sometimes occur. It will not stand constant moisture and will disintegrate if excessively sprinkled, especially when the roadway falls within the shadow of adjacent buildings.

BITUMINOUS ROCK PAVING.

Beds of rock thoroughly saturated with bitumen have been discovered in California and later in Kentucky. The California bituminous rock has been in use for about ten years, and is claimed to be much superior to the mastic prepared from the Trinidad asphalt, for the reason that it is not necessary to add any foreign substance whatever, but when ground and heated is ready to lay upon the roadway. For the Kentucky bituminous rock, it is claimed by those who have had long experience with the California pavements, to be superior to the California bituminous rock, for the reason that it is a granular sand-stone, which absolutely prevents the surface from becoming slippery unless covered with ice. It is also claimed that when holes are formed by toe corks, instead of sloughing off and enlarging, the bitumen runs together and closes up, and that it is not subject to disintegration by moisture. If these claims be true, the amount saved on transportation, and in the manipulation of the material, should certainly give us the bituminous rock paving at a considerable reduction from the cost of asphalt. All lovers of first-class pavements will earnestly hope that these claims may be thoroughly confirmed by the crucial test of time and experience.

As to the special merits of the asphalt or the bituminous rock paving, perhaps no better authority can be cited than that of Captain F. V. Greene, and the fact that his skill and ability have secured for him the vice-presidency of the Barber Asphalt

Company, should not detract in the least from the force of his statements.

"All things considered, it is the most satisfactory solution of the paving problem yet devised. It is not as durable as steel, nor as noiseless as velvet, nor does it afford as firm a foothold as the loose earth of the race track; but it is much smoother and less noisy than stone, much more durable than wood or macadam, is water-proof, contains no vegetable matter, can be kept perfectly clean at very slight expense, is less slippery under ordinary conditions (as shown by careful observations in Europe and America), than either wood or stone, and it enables larger loads to be drawn by the same force, and with less wear and tear on vehicles than any other form of pavement ever used."

BRICK PAVEMENT.

It is now hoped, and by many believed, that brick pavements will soon be, if they are not already, a formidable rival to the asphalt, with the durability of granite, and at a cost of at least 30 per cent. less. Experiments in this direction have been in progress for fifteen or twenty years, both east and west of us. Cincinnati has been very slow about investing in brick pavements, preferring to await the experience of others.

Until very recently the manufacturers of brick for street purposes have failed to realize the importance of thoroughly grinding and tempering their clay and burning it to a uniform and perfect hardness.

The Hallwood brick lately introduced come very close to all the requirements of a perfect street paving brick. They are 9 x 4 x 2⅝, with edges rounded and two grooves one-eighth of an inch deep running round the entire surface; the rounded edges are intended to prevent spalling and to facilitate the filling of the interstices with the paving cement. This paving cement is the same as used in the granite block paving, and about one gallon per square yard is required.

Brick may be laid upon any suitable foundation, but preferably upon concrete 6 to 8 inches deep, with a layer of 2½ inches of clean, sharp sand.

As to quality, the brick must be very hard and specially burned from selected clay thoroughly ground and tempered, of uniform size and quality, perfect in shape, and free from flaws or other defects. They are paved on straight lines across the roadway, at right angles to the curb and perpendicular to the roadway grade, with joints broken by a lap of not less than three inches. The brick are set as closely together as possible, and thoroughly rammed. This is done with a flatter about 14 inches square, upon which the blows are struck with a paving rammer of about 40 pounds weight.

The crown of a brick roadway should have an average rise from the gutter to the center of two-fifths of an inch per foot, but so adjusted that for a 30 feet roadway there is a rise of 4 inches from the gutter to a point half way between the gutter and the center, and a rise of two inches from said point to the center. This gives a very good cross section, and when complete the eye can detect no difference between this and a perfect arc of circle. A coating of one inch of clean, sharp sand completes the pavement. I examined a pavement of this character recently laid in Walnut Hills. It presented the appearance of perfection in brick paving. No brick could be found upon which any impression will be made by ages of frost or rain. They are harder than any granite paving which will not take a polish.

The essentials of a good street pavement, as stated by Gen. Q. A. Gilmore in his standard work on streets, are first, "that it shall be smooth and hard in order to promote easy draft; second, that it shall give a firm and secure foothold, and not become slippery from use; third, that it shall be easily cleaned and shall not absorb and retain surface liquids, but discharge them quickly into the gutters and catch-basins; fourth, that it shall be as noiseless and as free from mud and dust as possible; fifth, that it should be readily taken up and repaired; and sixth, the roadway surface must be constructed of durable material."

In all respects the brick pavement above described fulfills the conditions as nearly as any good pavement yet constructed. It may be said to be inferior to asphalt on account of the numerous small joints, which may absorb surface liquids. This

is remedied at first by the paving cement, and if this should rot out, as it probably will in a few years, fine sharp sand can be easily rammed into the side joints, so as to make them practically water-proof, leaving only the small end joints open to this objection. On the other hand, the material is far more durable than any asphalt with which Cincinnati has yet had any experience.

With regard to facility of tearing up and repairing, a brick pavement, known as the Hale patent, and hailing from Staunton, W. Va., would no doubt be superior to the brick pavement above described. In this pavement the concrete is replaced by plank laid upon three or more inches of sand; the plank being not less than 10 inches wide, 12 to 20 feet long and one inch thick, laid parallel to the curb lines, with broken joints. In all other respects it may be laid in the same manner as the first described brick pavement. "The materials being all disconnected can be rapidly taken up and laid aside, and as rapidly replaced at small expense, no new materials being required, and no patching to be done, everything fitting in its place." When subjected to extraordinary heavy loads, the plank, by their elasticity and by spreading the load over a greater surface, tend to prevent the crushing of the brick. Where sand is abundant and lumber cheap, this foundation can be put down for 50 to 60 per cent. less than concrete. It would be more elastic but less durable than concrete. The plank must decay in time, and be renewed, while the concrete is permanent except when torn up. In that case the bond is broken, and the concrete as concrete is destroyed, but the broken stone can be again used to make new concrete.

One great advantage of brick pavements over bowlders, granite or asphalt, is the rapidity and ease with which they can be laid, requiring very little skill and that easily acquired by any laborer of ordinary intelligence.

Figures are not interesting, but this paper would certainly be incomplete if it did not exhibit the fact that it is cheaper to have a good, substantial brick pavement than the wretched broken stone which we now endure. On account of the great variety of circumstances and difference in cost of materials in

various localities, it is difficult to present an accurate estimate, but the following is probably as fair a showing for the broken stone as it would be possible to make anywhere. Omitting items of actual cost which are common to both classes, a comparison will stand as follows, per lineal foot of 30 ft. roadway:

6" of sand @ $2.00 per cubic yd..............	$1.10 per lin. ft.
Brick at $16.00 per M........................	3.00 per lin. ft.
Plank, 30 ft. B. M. @ 2 cts..................	.60 per lin. ft.
Paving cement, 3⅓ gallons....................	.33 per lin. ft.
Total cost per lin. ft. of 30 ft. brick roadway.	$5.03
Broken stone, 14" deep, @ $1.50 per cubic yd..	$1.80 per lin. ft.
Gutter flagging, 2 ft., @ .70 per ft........	1.40 per lin. ft.
Gravel, 2" deep, @ 2.00 per cubic yd..	.28 per lin. ft.
Rolling twice, 6⅔ sq. yds. @ .05 per sq. yd....	.33 per lin. ft.
Total cost per lineal ft. for broken stone, roadway 30 ft. wide.................	$3.81 per lin. ft.

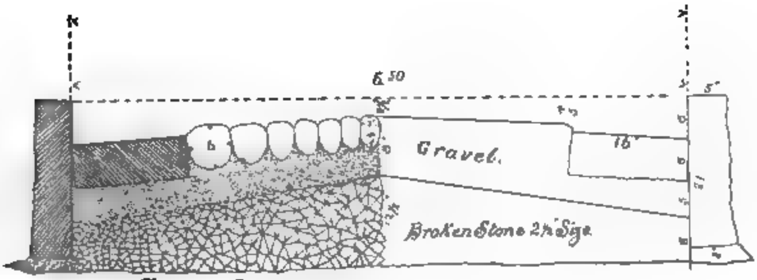
Supposing that the brick pavement would be entirely worn out in twenty years, the account for that period would then stand as follows:

First cost of broken stone roadway..........	$ 3.81 per lin. ft.
Repairs, 3 sq. yds. @ 20c. per yd. per annum..	12 00 per lin. ft.
Total cost of broken stone for 20 years...	$15.81 per lin. ft.
First cost of brick pavement................	5.03 per lin. ft.
Repairs, 3⅓ sq. yds. @ 3c. per yd. per annum.	2.00 per lin. ft.
Total cost of brick pavement for 20 years.	$7.03 per lin. ft.

Showing a saving of $8.78 in favor of the brick, and this without taking into account the blessings of freedom from dust and mud, economy in expense of cleaning and sprinkling, wear and tear of animals and vehicles, saving in cost of hauling, sanitary benefits from excellent drainage, and increased value of abutting property. This amount represents the interest at 4 per cent. on an investment of $11.00 per lineal foot. Thus we find that the actual saving to the city treasury would convert all our old turnpikes into handsome brick boulevards, although no part of the expense might be assessed upon the abutting property.

One of the most pleasant features of smooth streets is the ease and economy of cleaning. Upon the limestone, bowlder, and macadam streets the surface is so ragged that the best street sweeping machine could have but little effect. As a practical illustration, I witnessed the thorough sweeping of 6600 square yards of granite paving by four road sweepers in seven minutes. Estimating the time as ten minutes instead of seven, the wages of four drivers at \$2.00 per day of eight hours each, and eight horses at \$1.00 each per day, would make the direct expense 33 cents for sweeping 6600 square yards; if we double this for interest and wear and tear of machine, the expense would be 66 cents, or 1 cent per 100 square yards.

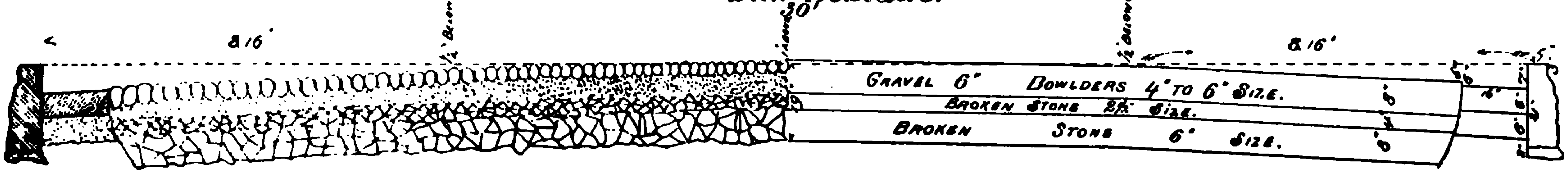
In conclusion, allow me to thank the officers and members of this Society for the opportunity to present this crude but faithful effort to set forth, without fear or favor, the merits and defects of the various pavements now seeking public favor. If this shall in any way assist you in solving the problem of better pavements, I shall be amply repaid for the time and labor spent.



Cross Section for Bowlder Pavement for Alley.

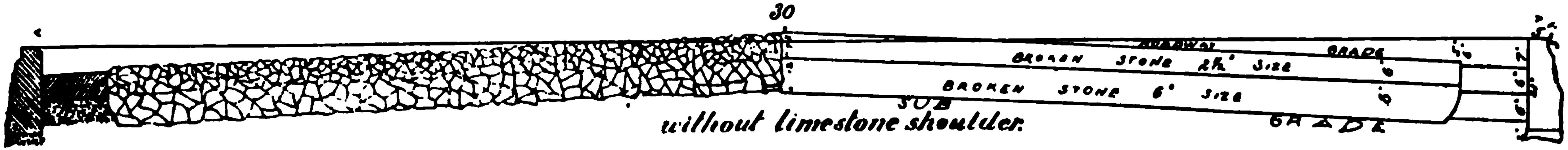
Cross Section for constructionof Roadway

with Bowlders.



Cross Section for constructing roadway.

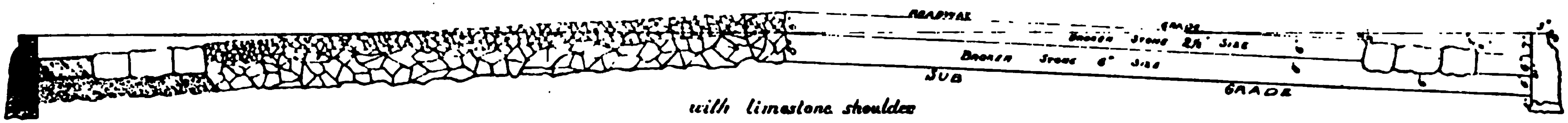
with broken stone



without limestone shoulder.

Cross Section for constructing roadway
with broken stone

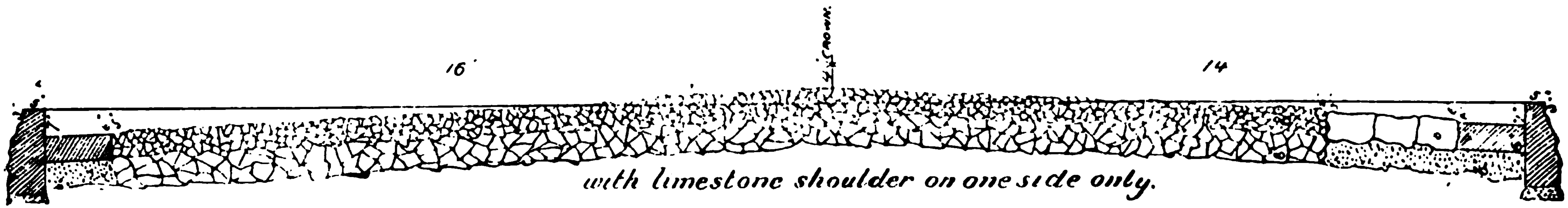
30'



with limestone shoulder

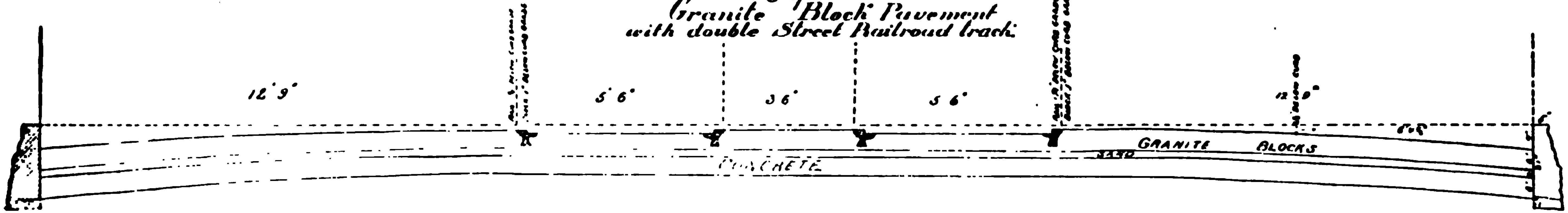
16'

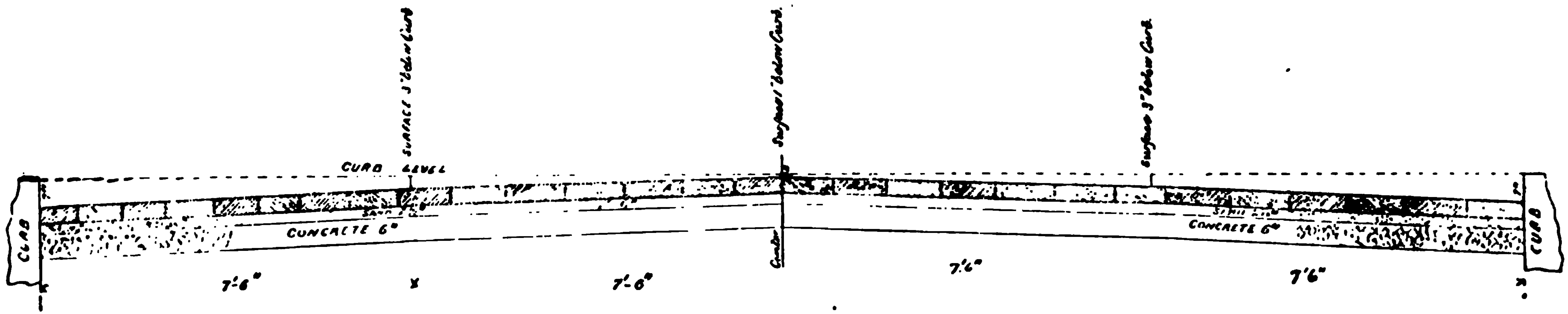
14'



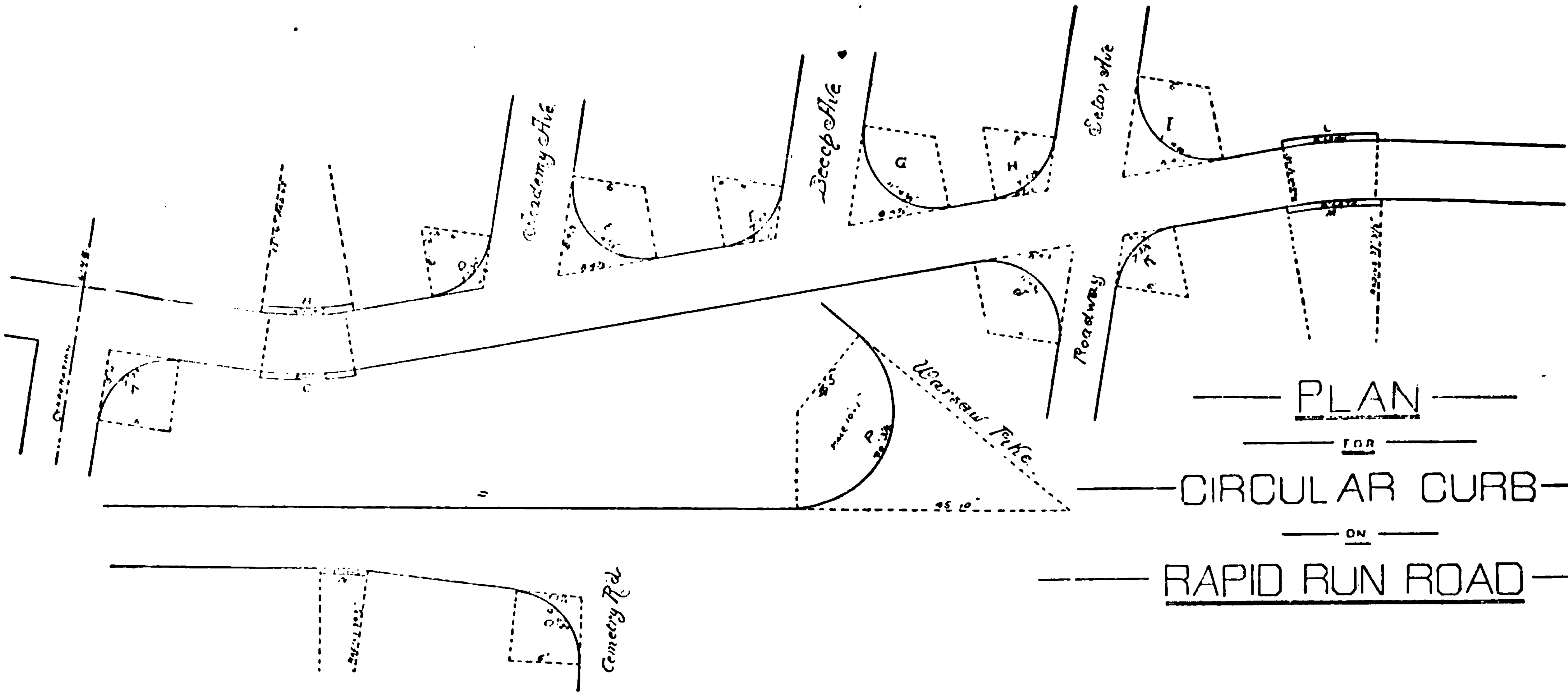
with limestone shoulder on one side only.

Cross Section for Construction of Granite Block Pavement with double Street Railroad track.





Plan for Constructing Brick Roadway.



PLAN
FOR
CIRCULAR CURB
ON
RAPID RUN ROAD

DISCUSSION.

From time to time during the reading of this paper, Mr. Mathewson illustrated methods described by means of drawings on the blackboard.

In connection with the subject of block pavement, Mr. Mathewson stated that while the amount of block pavements put down in this country is very small, yet in foreign cities they are laying great quantities of it—that is of wooden blocks. It is laid on concrete, and seems to have some glazing over the top, probably some preventive to keep the moisture from penetrating the wood and thus destroying it.

In regard to granite block pavements, during the discussion which followed the reading of this paper before the Cincinnati Society recently, a gentleman whose business was that of laying street car tracks, said that he was rather a street destroyer than a street builder, but that in destroying pavements he had made it his business to examine same carefully; and in regard to granite pavements, the best he had ever seen were in Baltimore, where no tar was used, but the blocks were laid as closely as possible and the spaces between filled with fine sand. On close examination when taking this up, he found that nowhere had the water penetrated more than two inches in the sand, as he could determine by the discoloration where the water had penetrated. This was an interesting fact, as Cincinnati had just laid about about a million yards of granite pavement, the tar for which cost about three hundred and fifty thousand dollars. The sand could have been put in for about ten cents per yard, making a big saving, and perhaps make a better pavement than that now had.

In regard to asphalt pavement, Mr. Mathewson said a bed of asphalt has been discovered somewhere in Kentucky, but he had been unable to find out much about it. Some pavements have been made of it in Brooklyn, and it is claimed to be better than Trinidad asphalt. A company has been formed in Cincinnati to put it down.

Mr. Harvey: In our part of the country, to speak of limestone without qualifying, does not mean much. We have the Clinton and Lower Helderberg. The Clinton is very rot-

, but on the other hand the Lower Helderberg is very ferent, approaching to the value of granite. We find it a y excellent building material, and have been importing it m adjacent counties.

Mr. Mathewson: The limestone we use is that which is ten out of the hills surrounding Cincinnati; it wears very idly.

Mr. Harvey: Prof. Orton gives the Lower Helderberg a y good reputation in a paper of his on Building Stone.

The Attempt to Build the First Free Turnpike in Tuscarawas County.

BY W. M. RAY.

Read by O. H. Hoover, Surveyor of Tuscarawas County.

The members of this association must have noticed the unusual interest now taken by the press and people generally in the condition of our country roads. In the leading magazines and dailies we find such articles as this:

"It is little consolation to the man who must cart his produce for miles to market, who loves the carriage, the wheel, or the saddle, to be told that we have the best railroad system in the world. That cannot console him for the fact that we have the worst highways. Road-making is an art that has never been learned in the United States. The farmer who would smile at using tallow candles, or threshing with a flail, goes on 'making roads' by tearing up the sod at the side of the road, and heaping in the middle. He is ignorant that this is as primitive a method as carrying mail on horse-back."

Quotations from Colonel Pope's speech at Buffalo, on the the subject, have been widely published. Our country papers have taken the matter up, and hardly an issue comes without an article on roads. Nor are these effusions wholly confined to hopeless grumbling as heretofore. Great schemes for road making and road mending are set forth to the great confusion of those who read them for information.

To be brief, this stir has reached our county, and supposing that it may have touched other localities, I want to give a general idea of the difficulties we have met with in the construction of our first Free Turnpike, in the hope that you may be profited by our experience.

In Tuscarawas county, extremes meet in the matter of dirt roads. The bottoms and terraces of the Tuscarawas furnish the best of dirt roads. The gravel and sand make a firm,

hard track which, with moderate attention in the way of a load of clean gravel here and there, and a cleaning of ditches twice a year, furnish the fine drives near New Philadelphia and Dover. But on leaving the Tuscarawas to ascend the Big and Little Stillwaters, or to traverse the hill country, you have the clays, which abound in a coal country, to try the quality of your vehicle and the patience of its driver.

Uhrichsville and Dennison (the Twin Cities, as they call themselves), lie on the banks of the Big and Little Stillwater Creeks. Together, the towns have a population of about 6000. About two and one-half miles distant is the village of Trenton, on the Tuscarawas. This is the terminus of the good roads. It became necessary that there should be some way of getting the garden products of the river bottom to the markets of the manufacturing towns. A bridge must be built over two miles of mud.

Action was begun early in last year. It was thought best to have the whole course of the old road thoroughly investigated. Viewers were regularly appointed March 19, 1889, for the survey of the proposed route of the Uhrichsville and Trenton Two-Mile Assessment Pike, from the west line of the incorporated village of Uhrichsville to the Trenton river bridge.

This survey was not accomplished without incident. Although every man in the country knew that road to be a State road, sixty feet wide, each one was equally certain that none of the sixty feet could in any way come off *his* meadow or corn field. The party went ahead bravely, however, assuring the land-holders that if the old Trenton and Cadiz road did not run just where they (the viewers) put it, it was for them (the land-holders) to prove that it ran somewhere else. And as all land marks had long since disappeared, the land-holders recognized the logic of the argument.

The profile of the road was found to be quite simple, the grades being comparatively easy. The important matters were, to get the road up out of the water in the bottoms, and to get a good road-bed over the 52 cut hill. At this point the Pittsburgh, Cincinnati & St. Louis Railroad crosses from the Stillwater to the Tuscarawas valley through cut No. 52. The

old road once had a good crossing over this hill; but the cutting done by the railroad, together with the subsequent slips, converted the old road-bed into Panhandle property at a great rate. The viewers located the road farther back against the hill, necessitating a great amount of cutting to secure a crossing on the old grade. It was determined to do this work, the Engineer of Maintenance of Way promising to drive piling and securely protect the road against similar mishaps in the future.

Another cut at the Uhrichsville line furnished about all our excavation work, estimated at 20,000 yards. The embankment was made to balance the excavation. We had just eighteen feet over two miles of road to build

After much discussion, it was determined to build a macadam road, eighteen feet wide. Now came the question of material. We have no limestone in our county, and that material seemed out of our reach on account of its cost. However, our iron works furnish an inexhaustible supply of furnace slag, easily accessible. There are also near the road, quarries of a fine, close sandstone. The viewers and myself thought it best to attempt the construction with materials at hand, and by one experiment determine their value in road work. Time will tell whether we have sacrificed excellence to expediency in this matter.

The first mile of our work was evidently the worst part of it. We determined to build a bottom of sandstone, one foot thick, the sandstone to be broken to pass through a four inch ring. This bottom to be covered with furnace slag, six inches thick, broken to pass through a two inch ring. The remainder of the road was of much better material, and we decided that it could be built with a covering of slag one foot thick.

It will be observed that we adopted the macadam system, having our bottom of finely broken stone. The Telferd system, in which the fine material is laid upon a rough floor of large stones being discarded as unsuitable to the soil with which we had to deal. At some of the town improvements large stone had been used, and they invariably worked up through the other material in soft weather, giving the roads the appearance of a giant's causeway in miniature.

Stone and slag were calculated at $1.00 per yard on the road, making the estimate of the whole work about $13,000, a large looking sum for so short a road as the Two-Mile, people were inclined to think.

The Commissioners having received our report on June 1st, appointed a day for ascertaining whether the petitions constituted a majority of the land-owners in the two-mile limit. After three days of hard work they decided that, counting the lot-owners in the three towns, a majority of the land-owners had signed the petition. The Uhrichsville and Trenton Two-Mile Assessment Pike at that moment became a reality — on paper — and the County Surveyor was made engineer of the new improvement. He immediately set about, giving his $1000 bond, and made the final location and profile in July.

As this was the first work of the kind ever done in our county, a system of letting was adopted which would give every bidder a clear conception of what he was buying, and also give small contractors a chance at the work. The road was divided into half-mile sections — the smallest allowed by law — making four sections on our road. The advertisement read as follows:

"The road is divided into four sections of one-half mile each, to be sold as follows: Section One at the school house; Section Two at the culvert, near Mazurie's; Section Three on the hill at 52 cut; Section Four at the Trenton bridge; and the bids will be received for any section or sections, or for the road as an entirety. Bids may be for grading or macadamizing with stone and furnace slag, or for all combined."

This letting took place July 26; please notice the dates. The Commissioners worked diligently auctioning off grading, stone work, slag work, and whole sections; but it was nearly evening when our party returned to the first section to offer the "road as an entirety." Every man now understood just how every job had sold and could bid intelligently. The contract was finally awarded to one party for $12,790, to be completed by the 15th day of November.

Now the thing was fairly started. Work was commenced Wednesday, August 7. Everything seemed propitious, for a time. We did not run against that almost inevitable stump,

an injunction, but were nearly brought up short by a remonstrance. It was claimed that the signers of the petition had acted under the impression that the county at large sustained one-half the expense of the proposed improvement. Here was a great to do. Another meeting of the Commissioners and an investigation revealed the fact that the petitioners were all right, and that it was the enemies of the road who were making the disturbance.

As I said, the contract was to have been completed by November 15. We had singularly favorable weather up to that time; but the contractor took railroad work, neglected his opportunities, and the 15th found him with the road half done, and a forfeiture of $10 per day hanging over his head. It has rained ever since. He is now working in mud two feet deep. He can't stop, or the Commissioners will hold the forfeiture. The populace of the region is belaboring the whole management with unsparing tongue. From March until January this unfortunate enterprise has struggled on, and 1890 finds it bemired in the most unfavorable season we have had for years.

It is but justice to say, however, that the parts of the roads already completed are doing well. Judicious underdrainage has rendered hitherto impassable spots firm and reliable. The slag used has been of good quality, and is standing the wear of heavy hauling that would break our best dirt roads. The whole work remains, as yet, at the contractor's risk; and he has all repairs to make that have been necessitated by his heavy hauling. Therefore, we hope on.

In conclusion, I wish merely to state the moral of this tale, *Begin soon.* The mills of the county gods grind so exceeding slowly that we have discovered its truth in the midst of a dark experience.

DISCUSSION.

An incident which came under the observation of one of the members present was related by him, where a few interested persons by dint of perseverance, succeeded in securing excellent roads all through their township, making the roads thereabouts the best in the State; but he thought it the people in other portions of the State would take like interest in the matter, we might have excellent roads and turnpikes all over the State.

Maintenance of Way on Railroads.

Almost twenty-five per cent. of the expenditures of American Railroads is for maintenance of way and repairs. In no department of a railroad are there easier ways of wasting money and opportunities. Where the Maintenance of Way Department is well conducted throughout with perfect system and economy, the General Manager has accomplished more than half his duty to the public and to his employes. If this department is first-class, all other departments are sure to be first-class; but we are sorry to acknowledge that this rule does not work both ways. Many roads that run the finest of vestibule trains and flood the country with brilliant red, yellow, and blue advertisements, run over very poor track at a rate of speed of forty to sixty miles per hour, and newspapers are right, after an accident, in calling such roads death-traps. Others keep up a passably good track at a cost fifty per cent. too heavy for the best.

The different departments of a railroad have not been developed uniformly. Most noticeably behind on many roads is the Maintenance Department, which can be conducted the most economically when the track is nearest perfect. On the contrary, as little money as possible is put in keeping up track, and the equipment and methods of advertisement are brought to a high state of perfection. It is possible to reduce the list of railroad accidents, caused by defective track, to almost nothing, and at a very small extra cost. Of course, the percentage of accidents caused by defective track is but small, and the accidents caused by faults of the telegraph and transportation departments will always be large on account of the number of cheap and incompetent men that they frequently place in responsible positions.

Who should have charge of the Maintenance of Way Department? The General Manager or General Superintendent is the head, but under him there are different methods. Sometimes the Roadmaster is next in rank, and there is either no

Engineer, or he is consulted only on rare occasions. Again the engineer is second, and has full authority over the road-masters and supervisors, or the engineer and roadmaster are considered officers of equal rank. Other things being equal, any business is best conducted when under one competent and responsible head, instead of having responsibility so placed that it can be shifted upon others. The Maintenance of Way Department is no exception, and the Engineer should have authority upon all questions. A few roads even improve on this, and have the Engineering Department include maintenance of track, bridges, and structures, all surveys, new work, and right of way.

Everything done toward improvement of track should be done in accordance with a plan for finally making the track as near perfect as possible. This requires the immediate direction of an engineer, capable of observing the most minute details as well as the ability and experience to make the plans for the improvements so complete that the little done here to-day and some place else to-morrow will in the future, after years of perseverance, join together in one harmonious whole.

To carry out a plan of this kind is frequently an up-hill business; superintendents often can not see the advantage of a little extra present expenditure, and it is a well known fact that supervisors and foremen are averse to taking instruction concerning work under their direction, unless from authority that must not be disputed. There are exceptions, and an exceptional trackman in this respect is a jewel worth keeping. The first work towards making a maintenance of way cheap and easy should be done when the railroad is located and built. It could be so well done at first that there would be no faults of original construction to remedy, and the cost of maintenance considerably reduced.

To do this, the company must have money enough to disregard all minor considerations and construct in a manner that will prove economical for a century instead of for the first few years. Such a road is the new Chesapeake and Ohio line from Ashland, Ky., to Cincinnati, O. On this, the maximum curve is 3°, and the maximum grade ¼ per cent., a splendid chance

for the maintenance of way department to make and keep up a perfect track at a light expense, if well operated. Few roads are built in this manner, for it is far more common to make present work as cheap as possible, and leave the future to take care of itself. The most familiar example to me of this method of building is the Scioto Valley, between Columbus and Portsmouth. For five years the present management has been busy correcting the faults of construction and location, and even yet a good many remain. In building this road the first consideration was cheapness; good alignment and good grades were entirely disregarded even where there was but little difference in cost of construction. Curvature was unlimited, and the maximum grade of one per cent. was put in wherever possible, whether for 300 feet or for a mile, with the natural consequence of heavy pulls, constant breaking in two and difficulty of controlling trains.

We will assume now that we are to deal with the average road which is neither very good nor very bad. From an engineering standpoint there must be standard plans for everything, from the manner of setting spikes to the most complicated structure on the road. Where these plans are adopted, they should be rigidly adhered to, and that assures uniformity throughout the road. The carpenters, trackmen, and other workmen should receive minute instructions in manner and method of doing work. This may seem to advocate reducing men to mere machines, but when the system is correctly carried out it is exactly the contrary. There are always some foremen who are naturally enterprising and progressive, and will devise methods to do work much cheaper and better than others. Engineers and roadmasters should be with their men as much as possible, and whenever they see better practical methods of work they should recognize the inventor, give him just praise, and instruct their other men in his methods. The ideal roadmaster would be a practical trackman with a good engineering education and training, but there are few men who would meet these requirements. The next best thing is to have an engineer who fully recognizes the importance of the experienced and practical trackman, and a roadmaster

willing and anxious to carry out the engineer's instructions. No practical engineer is so well acquainted with track that he cannot learn from a sectionman, and no experienced trackman is so good a workman that he can put up and maintain first-class track with no help from the engineer. Many roads after they are once built do not go to the expense of employing a good engineer, but repairs are kept up in a haphazard way in charge of men who can work for smaller wages. A wide-awake engineering department at the head of maintenance of way will give good track and comparatively small expenses. It is not possible in the space of a short paper to speak separately of the many things to be considered in maintenance of track, but a few points of especial interest to engineers will be noted.

As railroads are now operated, we must prepare for speeds of sixty miles per hour in passenger service by trains consisting of heavy engines and cars, and in freight service for trains of fifty loaded cars. To make track safe and economical to operate under these conditions, we should have transition curves to connect curve and tangent, and vertical curves to connect different grades. Until very recently, but little attention has been paid to this work, but on roads that have many curves and frequent changes of grade, they are becoming a necessity and receiving more notice. Many methods for running in easement curves have been used, two of the most practical being by Prof. S. W. Robinson and Wm. H. Searles. Another method by A. M. Wellington will be given soon in the *Engineering News*, probably within a month. In speaking of vertical and spiral curves, I will quote occasionally from the articles on the subject by Wellington, Robinson and Searles.

The easement curve is usually regarded as complex, theoretical and difficult to reduce to practical work in the field; on the contrary it is very practicable, and almost as easy to lay down on the ground as a circular curve. It is by no means a theoretical refinement to be discussed in the office and never used in practice. It is an absolute necessity for a perfect track or for the transfer of trains at high speed from a tangent to the circular curve, without disturbing the lateral equilibrium, caus-

ing the disagreeable lunge or swing to the car that is so frequently noticed.

In practice these easement curves are always found in first class track, whether laid down by the engineer or not. The circular curve may be perfectly staked out, but to the eye of the experienced trackman it does not look right, he will not follow the stakes, but will go back on the tangent and begin the curve gradually, throwing the track until it looks right to his eye, or until, as he says, it will "ride easy," thus frequently making a very good spiral.

Practically this will produce a curve that will ride much easier than the perfect circle, but it is at the best only a blundering way of the workman to correct the engineer's lack of attention to detail. Examine almost any curve in old track, and you will find the end of tangent thrown out a little, so the easement curve can be put in and join the circular curve correctly. Even with this the effect is to compound the curve, and there will be a small arc between the easement curve and regular curve, of shorter radius than the latter.

The section foreman must do the best that he can, for he is expected to keep his track so it will ride smoothly, which he certainly can not do if he follows the circular arcs at the beginning of curves as usually staked out by the engineer. Several curves have been proposed to affect this easement from curve to tangent, and a few have been used and tabulated. This curve must be a kind of spiral, with an infinite radius at the point of leaving the tangent, and with gradually increasing curvature, until it equals that of the circular arc to which it is to be joined.

The easement curve now used on the Scioto Valley is the one fully discussed by Wm. H. Searles, C. E., in his little book "The Railroad Spiral."

"The easement curve must throughout its length maintain perfect continuity of proper relation of the radius of curvature and rail elevation. That is to say, to meet the above conditions, the radius of the easement curve must change from point to point; and the rail elevation at any one point must be precisely that required for the radius at that point. The relation

of elevation and radius is well known, viz: the elevation is simply the inverse ratio of the radius. Or again: the product of the elevation and radius of curvature is a constant for any given number of miles per hour for speed of train. This is true whatever the form of easement curve, and hence the latter is neither determined nor influenced by that relation.

Being free to assume the law of the easement curve, it appears that the very best conditions to adopt for fixing it are to assume, first, that the car in tilting to the difference of rail elevation as it passes along the easement curve shall rotate upon a longitudinal axis passing through the center of gravity of its cross-section; and, second, that it be accelerated in that tilting movement so that a passenger at the side of the car shall experience only the sensation of a slight change in his own weight while on the easement curve. That change of weight will be an increase if outside and going from the tangent, and vice versa. This change of weight, however, should be made imperceptible, and it is believed so to be when the radius of curvature varies inversely as the square of the distance from the point of tangency. The object in choosing the square is to reduce disturbances due to entering upon the curve to the least possible value. This makes the law relating to the time and rail elevation identical with that of falling bodies, or with $h = \frac{1}{2} ft.^2$ where h = elevation, f = the constant at elevation and t the time. By choosing the law of the square the acceleration of the car in its rotation upon a longitudinal axis is made constant.

These curves should be understood as forming the proper path for the center of gravity of the car and not the center line of track. This center of gravity is at a height above the track about equal to the gauge of track. It appears that in order to make this center of gravity describe the curve as laid down, the curve should be moved out a distance equal to difference of elevation at each point."

The theory of the transition curve as given above is said by Professor Robinson to be the most perfect possible form of railway curve, and he has calculated the formulae and tabulated a number of curves for the use of engineers. From an

examination of his table, we find that the curve would be easily used in the field, and would give about the same length of elevated outer rail between the level track and maximum elevation of outer rail that is now used in practice by the best railroads. In laying out a new line it would be without doubt the best curve to use, but in old track it is better to use the spiral given by Wm. H. Searles. Professor Robinson's formula will bring the track inside of a regular circular curve, and when used on track already constructed, will make too much change of road-bed and track. The spiral given by Mr. Searles in his book is constructed upon a series of chords of equal length, the curve being compounded at the end of each chord. The chords subtend circular arcs, and the degree of curve of the first arc is made the common difference for the degrees of curve of the succeeding arcs. The elements of many different curves have been tabulated by Mr. Searles, and it is but little trouble to select a proper spiral that will fit the curve very closely, or throw it a little in or a little out. This curve is not as perfect as that given by the formulae of Professor Robinson, but it will give a curve that is perfect for all practical purposes. In fitting spiral curves to old track, first notice the rail joints and see if they are too tight, too loose, or just right, and the selection of the spiral and curve will be governed accordingly. If the degree of curvature of the circular center is left the same, or only slightly increased, the curve will be thrown in and shortened, and consequently the joints tightened. If the joints are all right and the length of curve does not need changing, a short calculation by formulae 16, 17 and 18, "Searles Railway Spiral," will give the correct degree of curvature for central part of curve, and the curve will be thrown in at the quarters and out at the center. If the central curvature is increased, the curve will be lengthened by being thrown out more. The spiral chosen should be such that the elevation could begin at the beginning of the spiral and increase at the rate of one inch for every 60 to 70 feet, and reach the full elevation where the circular curve begins. As an example of field practice, I will take a 6° curve that was recently changed to a spiral. The curve was in a long stretch of track

that was very convenient for trains behind time to catch up a few minutes, and a speed of 45 miles per hour was common. The curve had been giving the trains a disagreeable lurch at several points.

The central angle taken at the apex was 72° 34′, giving a tangent of 701 ft. Measuring back this distance on the tangents, I first obtain the P. C. and P. T. of the original 6° curve, and by measurement on the present center find that the track has been thrown in and is shorter than the regular curve. The joints are also too tight, so the new curve must be several inches longer than the old. The elevation of outer rail should be 4¾ or 5 inches, therefore the spiral should be in the neighborhood of 300 feet long. Making calculation about as in the example on pages 30, 31 and 32 of Searles' "Railroad Spiral" I find that a spiral of 10 chords of 29 ft. each and 6° 12′ for the central part of curve, will be what is needed for making the curve a little longer to loosen the joints. This long example referred to above is shortened very much by practice, as the engineer soon has a list of curves of different degrees and angles, and will need to make but a small part of the calculation to find exactly what is necessary for the particular curve.

The length of the original 6° curve of our example will be 1209.5 — the angle of the spiral at each end of 10 chords each is 9° 10′, leaving a central angle of 54° 14′, which will give 874.5 of 6° 12′ curve, a difference in length of 334.8 or 167.4 at each end, which is the amount the spiral laps over on the original curve, leaving 122.6 back on the tangent to begin the spiral. The original P. C. was at Sta. 1600 + 01.9. Therefore the new P. S. will be at 1598 + 79.3, from thence to 1601 + 69.3 will be spiral thence to 1610 + 44 will be 6° 12′ curve, thence to 1613 + 34 will be spiral. From the apex 823.6 on the tangents will give these points to begin the spirals. In running the curve the instrument is set at 1598 + 79.3 and the spiral run in, then moved up to 1601 + 69.3 and one-half the curve run. The same is repeated then at the other end of the curve, and the work if accurately done will meet within one-half inch or less on the central stake. The curve as above given was thrown in at the quarters about 2 feet, and about 2 feet 6 inches

out at the center, making it enough longer to loosen the joints. Trains now go around the curve at the highest rate of speed without any inconvenience.

In the actual operation of a railroad, it is the grades, not the curves, that occupy the most important place. It is impossible, or we might even say undesirable, to have a perfectly uniform grade from one end of a road to the other. Usually, the bulk of the profit that a road yields comes from its ability to haul freight cheaply and freedom from accident. For example, we will suppose that it has been determined to build 100 miles of railroad. The preliminary work is done and we can determine on a ruling grade, which for convenience we will say is one per cent. or 52.8 per mile. The usual way is to consider this as a maximum, and whenever and wherever it can be used to advantage in present construction it is used. The proper way to do is to construct a virtual profile, taking into account stops, curves, etc.; connect all grades by good vertical curves, and the expenses of construction will be but little more, while the economy and safety of operation will be greatly increased. The danger, trouble and expense of operation is increased by sags in the grade line that are frequently difficult and expensive to take out. Unless the sag in the grade line is deep enough to affect the ruling grade, its disadvantage is in the extra wear and tear of rolling stock, and the danger of breaking trains. "In a sag, to obviate all danger of the rear portion of the train crowding upon the cars in front, without the use of brakes, the rate of grade upon which the head of the train stands must in no case exceed that upon which the rear of the train stands by more than the grade of repose of the last car."

Mr. A. M. Wellington shows that curves should be 400 feet long, or 200 feet on each side of the vertex for each tenth in change of rate of grade per station, not over 0.025 per station if all possibility of bringing the drawbars of any part of the train into compression, while passing over it is to be avoided. With half this length of curve, all danger of "taking out the slack" in the front half of the train where there is the most danger of breaking the train will be avoided. Full discussion

and formulae for these curves is given in Wellington's "Economic Theory of Railway Location."

We have been using the curves now for nearly three years, and they give the very best satisfaction to all concerned, from the section men up to the superintendent. When track is worked over to stakes accurately set to spiral curves, and grades connected by good vertical curves, the result is surprising. See that the stakes are followed with *care and exactness*, and the section foremen will never afterwards deviate from them in the least, for they will have track that to their practical eyes will look just right, and will ride perfectly. Their pride in having good track will lead them to be more particular in all small details of every-day work, and in the end a railroad will be better off in every respect by having the engineering work well done, and competent engineers to have charge of maintenance of way work of all kinds.

Lecture by Prof. B. F. Thomas.

A very interesting and instructive lecture, illustrated by experiments and blackboard diagrams, was delivered, as per program, to the members of the Ohio Society of Surveyors and Civil Engineers, by Prof. B. F. Thomas, of the Ohio State University, on the "Electric Motor in Engineering."

It was the intention to have included the lecture in this report, but unavoidable circumstances have prevented the author from adapting and correcting the stenographer's notes of the same so that it could be published at this time.

Obituary.

To the Officers and Members of the Ohio Society of Surveyors and Civil Engineers:

Your Committee on Memorial, to whom was referred the matter of preparing Obituary Notice on the death of A. T. Bement, late member of said Society, report the following:

WHEREAS, In the course of events, *death* has again invaded our circle, and removed therefrom our worthy associate, Alden T. Bement, we desire to express and place on record our appreciation of him in life, and our deep regret at his death, and convey our earnest sympathies to those of his kindred who have been so sadly bereaved; therefore,

Resolved, That said Society has lost a useful member; the community in which he lived a good citizen, and his family a kind protection.

Resolved, That a copy of our next Annual Report be transmitted to the family of the deceased.

Your committee is indebted to Thos. R. Wickenden, C. E., of Toledo, Ohio, for the following history of the deceased:

Alden T. Bement was born December 24, 1816, at Woodstock, Vermont; died at his home in Toledo, September 8, 1888. He received his education in the public schools and an Academy of that State; came west in 1844, and was engaged in school teaching and mercantile business until 1852, when he turned his attention to surveying and engineering. In the early part of his professional career, he was engaged in the construction of what is now known as the "Air Line

ivision" of the Lake Shore & Michigan Southern ailway, his residence at this time being in Bryan, hio. He was later elected on three occasions to the ice of County Surveyor of Williams county, in which sition he gave general satisfaction. In 1881, he re-oved to Toledo, and was appointed Deputy Surveyor Lucas county until 1884, since which time until his ath, he was associated with his brother, S. Bement, general engineering business in Toledo.

In his work he was careful, methodical, and accu-e, and in his association with men he gave evidence being a thorough Christian gentleman, whose death loss to his friends and associates, as well as to the hio Society of Surveyors and Civil Engineers.

Respectfully submitted,

J. T. Buck,
O. H. Hoover,
Committee.

Phillip Rattermann was born in what is now the village of Berlin, Shelby county, Ohio, and which used to be the historic Fort Laramie, in 1842, and died at his brother's home in the same place after a lingering illness of more than a year's duration, on the 12th day of September, 1887, and was about forty-five years old. His parents emigrated from Germany, and he inherited their good habits of industry, energy, and perseverance. He was a good German and English scholar, being principally self-taught. He taught both English and German schools for a number of years, and studied and practiced surveying and engineering at the same time. He was elected County Surveyor of his county in 1884, and nominated for a second term the same year he died. His work was alike creditable to himself and satisfactory to the people, and while he was a constant sufferer the last part of his life, he was an equally constant and persistent worker in his field.

Mr. Rattermann was never married. He was a true gentleman with the highest sensibilities of honor and justice. He was a member of the Ohio Society of Surveyors and Civil Engineers, which has lost both a good friend and member; his county both a good citizen and civil engineer, and his relatives and friends a true and noble man.

D. W. Pampel,
W. H. Jennings,
H. L. Weber,
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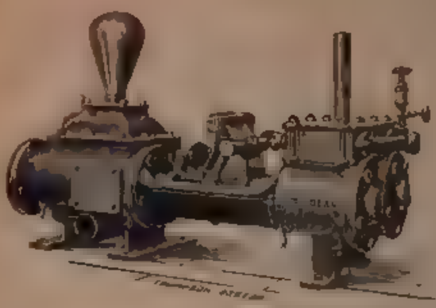

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WORKS AT

CANTON, - OHIO.

XVIII.

INDEX.

ADVERTISERS.

Twelfth Annual Report

OF THE

Ohio Society

—OF

Surveyors and Civil Engineers.

BEING THE

Transactions of the Society

AT ITS

TWELFTH ANNUAL MEETING,

HELD AT COLUMBUS, OHIO

January 20th, 21st and 22d,

1891.

TWELFTH ANNUAL REPORT

OF THE

OHIO SOCIETY

—OF—

Surveyors and Civil Engineers,

BEING THE

TRANSACTIONS OF THE SOCIETY

AT ITS

TWELFTH ANNUAL MEETING,

Held in Columbus, Ohio, January 20, 21 and 22, 1891.

Price, 50 Cents.

Postage, 8 Cents.

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INDEPENDENT COMPANY, PRINTERS.
1891.

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Highways—J. B. Weddell, *chairman*, Galion; H. C. White, Warren; Julian Griggs, Columbus; E. B. Opdycke, Bryan; H. L. Webber, Bucyrus.

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Legislation—C. N. Brown, *chairman*, Columbus; J. L. Cully, Cleveland; J. M. Harper, Cincinnati; B. F. Bowen, Columbus; F. M. Turner, Dayton.

Blanks and Instruments—L. W. Mathewson, *chairman*, Cincinnati; O. H. Hoover, New Philadelphia; R. E. Lowery, Eaton; F. A. Bone, Lebanon; J. Raudabaugh, Celina.

Special Committee on Preparing a Bill requiring Surveyors to be Licensed—C. H. Burgess, *chairman*, Cleveland; Prof. C. N. Brown, Ohio State University, Columbus; T. R. Wickenden, Toledo.

The Ohio Society of Surveyors and Civil Engineers, as a body, is not responsible for the statements and opinions advanced in any of the papers published in this report.

List of Members.

NAME.	BUSINESS.	RESIDENCE.
Arnett, Jonathan	Surveyor and Civil Engineer	London, Madison Co. O.
Atkinson, J. W	Assistant City Engineer	Galion. Crawford Co., O.
Bachtell, Samuel	Chief Eng. Public Works of Ohio	Columbus, Franklin Co., O.
Beckman, Louis	Manufacturer of Engineers and Surveyors' Instruments	Toledo, Lucas Co., O.
Bement, Samuel	Surveyor and Civil Engineer	Toledo, Lucas Co., O.
Benson, O	Bridge Engineer	Canton, Stark Co., O.
Bliss, Albert	Civil Engineer and Surveyor	Northfield, Summit Co., O.
Boggs, Edward M	Civil and Hydraulic Engineer	Redlands, California.
Bone. Frank A	City Civil Engineer and Surveyor	Lebanon, Warren Co., O.
Bowen, B. F	Surveyor and Civil Engineer	Columbus, Franklin Co. O.
Brown, Prof. C. N	Prof. of Civil Engineering O. S. U.	Columbus, Franklin Co. O.
Brown, J. R. C	City Civil Engineer	Ironton, Lawrence Co., O.
Bryan, R. A	City Civil Engineer	Portsmouth Scioto Co., O.
Buck, J. F	Surveyor and Civil Engineer	Cardington, Morrow Co., O.
Burgess, C. H	Civil Engineer	Cleveland, Cuyahoga Co., O., 32 Nottingham.
Buxton, Clifford	Chief Engineer { T. & O. C. Ry. / T. C. & C. Ry. / K. & M. Ry. }	Toledo, Lucas Co., O.
Cellarius, Fred. J	Asst. City Civil Engineer	Dayton, Montgomery Co., O., Room 3 City Building.
Connar, Thomas C.	County Surveyor	Zanesville, Muskingum Co., O
Cook, C. B	Civil Engineer	Hoquiam, Washington.
Craig, Samuel	Surveyor and Civil Engineer	Wapakoneta, Auglaize Co., O
Culley, John L	Civil Engineer	Cleveland, Cuyahoga Co., O. Room 28 Blackstone Bldg.
Davisson, Francis M.	Surveyor and Civil Engineer	W. Manchester, Preble Co., O
Doyle, P. H	Civil Engineer	Logan, Hocking Co., O.
Dunn, William	Deputy County Surveyor	Zanesville, Muskingum Co., O River St. 10th Ward.
Egerton, James T	County Surveyor	Ironton, Lawrence Co., O.
Fisher, John L	Civil Engineer and Surveyor	Tiffin, Seneca Co., O.
Gaffney, W. H	Civil Engineer and Surveyor	Logan, Hocking Co., O.
Ginn, Wilbur A	Civil Engineer and Surveyor	Bellefontaine, Logan Co., O.

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Gotwald, Robert C.	Civil and Sanitary Engineer	Springfield, Clarke Co., O.
Griggs, Julian	Asst. Eng. S. V. Division Norfolk & Western R. R.	Columbus, Franklin Co., O.
Grim, John C.	Civil Eng. and County Surveyor	Bryan, Williams Co., O.
Gyger, George R.	City Civil Engineer	Alliance, Stark Co., O.
Hanlon, J. A.	Civil Engineer	Coshocton, Coshocton Co., O.
Harper, Geo. B.	Gen'l Supt. and Chief Eng. Ky. Midland R. R.	Frankfort, Kentucky.
Harper, J. M.	County Engineer	Cincinnati, Hamilton Co., O.
Harvey, John	Surveyor and Civil Engineer	Hamilton, Butler Co., O.. 224 S. Second St.
Haseltine, Edwin D.	Civil and Mining Engineer & County Surveyor	Youngstown, Mahoning Co. O
Hill, George H.	Civil Engineer and Surveyor	Milford, Clermont Co., O., 29 Center Street.
Hall, J. H.	Civil Engineer	Canton, Stark Co., 16 E. Tuscarawas Street.
Hoover, O. H.	County Surveyor	New Philadelphia, Tuscarawas Co., O.
Humphreys, J. H.	City Engineer	Findlay, Hancock Co., O.
Huston, Samuel	Civil Engineer	Steubenville, Jefferson Co. O.
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Ireland, James	Land Surveyor	Morrow, Warren Co., O.
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Jones, A. W.	Asst. Eng. Wisconsin Cent. Lines	Waukesha, Wis.
Jones, E. C.	County Surveyor	Jackson, Jackson Co., O.
Judson, Chas. A.	City Civ. Eng. & Supt. Water Wks.	Sandusky, Erie Co., O.
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Mann, Harvey E.	City Civil Engineer	Ashtabula, Ashtabula Co., O.
Marble, Reuben R.	City Civil Engineer	Canton, Stark Co., O.
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Myers, W. E.	Instructor in Ohio Normal Univ'y.	Ada, Hardin Co., O.
Nicholson, Geo. B.	Chief Eng. C.. N. O. & T. P. Ry. and associate lines	Cincinnati, Hamilton Co., O 55 W. Fourth Street.
Opdycke, E. B.	Civil Engineer	Pulaski, Williams Co., O.
Pampel, D. W.	Surveyor and Civil Engineer	Sidney, Shelby Co., O.
Peters, Wm. E.	County Surveyor	Athens, Athens Co., O.
Pillars, James	County Surveyor	Lima, Allen Co.. O.
Pugh, A. G.	General Contractor	Columbus, Franklin Co., O.. 231½ N. High Street.
Raudabaugh, John	Surveyor and Civil Engineer	Celina, Mercer Co., O.
Reede, Wm	County Surveyor	Lilly Chapel, Madison Co., O.
Riggs, Morris J.	Bridge Engineer	Toledo, Lucas Co., O.
Rock, S. F.	Div. Eng. R., N., I. & B. R. R.	Irvine, Kentucky.
Sager, F. J.	Civil Engineer	Columbus, Franklin Co., O. 166 N. Nineteenth Street.
Sample, Jas. H.	Chief Engineer P. A. & W. Ry.	Granville, Licking Co., O.
Seitz, D. W.	County Surveyor and Civil Eng.	Ottawa, Putnam Co., O.
Sheldon, A. D.	County Surveyor and Civil Eng.	Whittlesey, Medina Co., O.
Sill, John S.	County Surveyor and Civil Eng.	Ashtabula, Ashtabula Co , O.
Snyder, Frank	Hydraulic and Sanitary Engineer.	Columbus, Franklin Co., O., 113 N. Fourth street.
Statleman, Gust. R.	Civil Engineer	Dayton, Montgomery Co., O.
Strawn, J. B.	Civil and Sanitary Engineer	Salem, Columbiana Co., O.
Sturgeon, Charles	Repres'g Columbus Sewer Pipe Co.	Columbus, Franklin Co., O.
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Walker, R. F.	County Surveyor and City Civ. Eng.	Troy, Miami Co., O.

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Weitzell, R. S.	Civil and Mining Engineer	Weatherford, Parker Co., Tex
White, Homer C.	County Surveyor	Warren, Trumbull Co., O.
Wickenden, Thos. R.	City Civil Engineer	Toledo, Lucas Co., O.
Wileman, E. D.	Civil Engineer and Surveyor	Massillon, Stark Co., O.

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George H. Frost		New York City.
John Graham		Columbus, Franklin Co., O.
R. W. McFarland	President Miami University	Oxford, O.
J. C. Mendenhall	Supt. U. S. Coast and Geodetic Survey	Washington, D. C.
Dr. Edward Orton	State Geologist and Pres. O. S. U.	Columbus, O.

TWELFTH ANNUAL REPORT

OF THE

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.

THE Twelfth Annual Meeting of the Ohio Society of Surveyors and Civil Enigneers was held in Lyndon Hall, at the southeast corner of Long and Fourth streets, Columbus, Ohio, January 20, 21 and 22, 1891.

The Society was called to order at 7 o'clock p. m., by the president, J. T. Buck.

The exercises were conducted essentially according to the following

PROGRAMME.

TUESDAY, JANUARY 20, 9 A. M.

Meeting of Trustees and Committees and arranging of displays.

TUESDAY, 1:30 P. M.

Report of Secretary. Report of Treasurer.

Report of Trustees. Election of Members.

Report of the Committee on Code. Oliver H. Hoover, *chairman*, New Philadelphia.

Report of Committee on Legislation. B. F. Bowen, *chairman*.

TUESDAY, 7 P. M.

*Paper—"Design for a Brick Arch." A. L. Morgan, Asst. Eng. C. & M. V. R. R., Zanesville.

Paper—"Railway Surveying in South Australia." E. D. Wileman, Massillon.

Paper—"The Louisville Southern R. R. and its Branches, with Notes on Construction." Samuel F. Rock, Div. Eng. R. N. & B. P. Co., Irvine, Ky.

Report of the Committee on Engineering. Chas. A. Judson, *chairman*, Sandusky.

WEDNESDAY, JANUARY 21, 9:30 A. M.

Report of Committee on Surveying. J. D. Varney, *chairman*, Cleveland.

*Not read.

Paper—"What Knowledge should be Required of Surveyors to Qualify for Practice." C. N. Brown, Associate Professor Civil Eng., O. S. U., Columbus.

Paper—"Land Surveying." G. S. Innis, Columbus.

Paper—"Transit Points." John L. Cully, Cleveland.

Address of President. J. T. Buck, Cardington.

WEDNESDAY, 1:30 P. M.

Report of the Committee on Drainage. Harry L. Weber, *chairman*, Bucyrus.

Paper—"Sewer Plans for Dayton." F. J. Cellarius, Dayton.

Paper—"Notes on Construction of Sewers." Chas. A. Judson, Sandusky.

Paper—"Separate System of Sewers." J. B. Weddell, Galion.

Paper—"Permanent Drainage." D. W. Sietz, Ottawa.

WEDNESDAY, 7 P. M.

Lecture—"Stored Power of the World." Dr. Edward Orton, State Geologist, Columbus.

THURSDAY, JANUARY 22, 8:30 A. M.

Report of Committee on Highways. Thos. R. Wickenden, *chairman*, Toledo.

Paper—"Improvement and Protection of our Domestic Water Supply." J. B. Strawn, Salem.

*Paper—"Photography for Engineers." R. H. Lee, Sharon Center.

*Paper—"City Surveys." W. A. Ginn, Bellefontaine.

*Paper—"Felling and Handling Large Trees on the Pacific Coast," C. B. Cook, Hoquiam, Washington.

THURSDAY, 1:30 P. M.

Report of Committee on Blanks and Instruments. F. M. Davisson, *chairman*, West Manchester.

Paper—"Brick Paving." H. L. Weber, Bucyrus.

*Paper—"Correction and Protection of Streams with Fascines and Fascine Levees on the River Rhine in Germany." P. J. Laessle, Chillicothe.

Paper—"Substructure for Bridges." W. K. Liggett, Columbus.

Paper—"Measure." D. W. Pampel, Sidney.

Unfinished business.

New business.

Election of officers.

*Not read.

Report of the Secretary.

I have not as yet written out any report of the Secretary. There have been a few suggestions made in the course of the year that I thought perhaps it would be well to speak about and see what you thought was proper to do. It is very convenient in reaching the members of the profession in the State to have a directory, and the suggestion was made about the time the last report was printed that such a directory be prepared, but it was not taken up soon enough to be acted upon and included in that report. It could be very easily managed by distributing proper blanks among our members in the State, and let them report the list to the person who prepares the next report, and in that way have a full report of all those who are practicing surveying and civil engineering. I think, probably, such a course would add somewhat to the membership, because we would be able to reach them with circulars and invitations, and it would be some advantage in extending our acquaintance, and it seems to me it would be a very proper thing to do.

There have been a number of circulars sent out during the year, some in regard to reports. We have quite a stock of old reports on hand, and the attempt was made to get these out among the members who wanted them, to make them valuable for whatever information they contain. Of course, they are not valuable stored in the office of the Secretary. There is still quite a supply there that have not been called for. I suppose it is always a good plan to keep somewhat of a file of our own, as calls are frequently made to fill sets and some sales are made. The Secretary had one application for a set of our reports to go to Japan, to a graduate of the University of Tokio, this year.

In regard to the names of the officers that are usually printed in the report, another suggestion was made. That the outgoing and incoming officers ought to be printed in the report, properly designated as a good many or some at least, wish to know these facts, and the officers who come in at the annual meeting are the persons who have had the least to do with the report as furnished to the members. That suggestion was made last year but not in time to carry it out. The report can always be gotten out pretty early in the year, if the members who furnish papers will give them promptly to the Secretary as soon as they are read, and not carry them away to be re-written, or revised perhaps, and sometimes they never get back to him, and after a good deal of delay the report has to be published without getting them in. I think the report every year could be out by some time in March without any trouble at all, if a little care was taken in having the papers properly prepared and turned in as soon as the meeting is over. In that way whatever there is in the report in the way of suggestion that is good is available to all the members for practice in the work of the coming year and it does us credit with the societies of other states.

There was an innovation this year in distributing the reports. Heretofore they have waited until nearly the end of the year and then sent them out in bundles, express charges following the bundles. This year they were distributed as soon as they reached the Secretary by United States mail, and postage prepaid, of course, which seemed an advantage, and I think there is no reason, except financial reasons, why that could not be done every year, and with our membership there ought to be no trouble about the finances. I have the treasurer's report, which I might read at this time:

REPORT OF THE TREASURER.

COLUMBUS, O., January 22, 1891.

To the Officers and Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—I herewith submit the following statemen. of the receipts and expenditures of the Society during the year 1890 as follows, to-wit:

RECEIPTS.

Received from the sale of Annual Reports		$ 19 22
Received from Membership Fees		21 00
Received from Annual Assessments for year 1888	$ 3 00	
Received from Annual Assessments for year 1889	20 75	
Received from Annual Assessments for year 1890	147 00	
Received from Annual Assessments for year 1891	108 00	
		287 75
Received from Advertisements for year 1889	72 50	
Received from Advertisements for year 1890	175 00	
		247 50
Total		$575 47

EXPENDITURES.

For labor bundling Reports		$ 1 50
For printing Annual Reports for 1890, 1,200 copies	$157 54	
For Plates for Annual Reports for 1890	27 00	
For nine Boxes for distributing to other societies	2 00	
		186 54
For other printing and stationery		37 34
For Stenographer's fees for meeting of 1889		42 80
For Stenographer's fees for meeting of 1890		44 16
Drayage		1 10
Expressage		37 25
Postage		50 40
Cash advanced by F. J. Sager, as per last statement		23 38
		$424 47
Cash balance in hand		$151 00

JULIAN R. GRIGGS,
Secretary-Treasurer, 1890.

DISCUSSION.

Mr. Cully: There are two very admirable suggestions made by the Secretary. One is in regard to the printing of the annual publication. Now, there is no State society that I know of which stands so prominently before the public as the Ohio Society, and there is nothing that will contribute more to that prominence than to have our reports out early in the season and I think the Secretary properly states it that this report might come out in March. The fact of it is, the reports have usually come out about the middle of the year, and it is very desirable that this report come out early, so I suggest to the members who have papers or reports to make that if they are not prepared to send them in immediately, if they require any revising, that they be revised at once. Now as to the other suggestion, in regard to a register of all the engineers and surveyors of the State: Incidentally, it would be an advantage to the society to know the surveyors of the State, and the engineers as well. Outside of that there is an advantage to the profession; for instance, a gentleman that lives in a populous district frequently requires surveys or engineering operations in other parts of the State, and is not able himself to supervise the work personally; he would like a surveyor or civil engineer at a particular locality, the nearer this locality to the work that is to be done the better; as, for instance, we may want a survey made of a piece of land that belongs to an individual in the community where you live. You are not able to go yourself, but if you knew of a surveyor near at hand you would send and get him, and this registry would be an aid to the profession that way as well as others, and if the labor is not too much I hope the register will be made this year.

Mr. Wickenden—Mr. Chairman: I appreciate, and I think we all do, the admirable advance made this year in the work of the Secretary and those managing the Society. There is one little thing which might perhaps be desirable, and which would not cost very much. It has been the custom that a list of the different committees shall be placed in the annual report. We, perhaps, do not have the annual reports always on our desk, and probably don't know just where we can get them at the time we want them, and this suggested itself to me: that if a list of the committees could be printed separately and sent before the report, that it might be advantageous both to the members of the committee and the members of the Society.

Mr. Cully: I would say that I think that is a very good suggestion. I was not at the meeting last year, and the query in my mind was: who are on the different committees? Late in the season I found that I was on a certain committee, and it made it late for me to prepare any notes for reports. Of course, the same was true with other gentlemen. If the committees could be notified, as of course there are some persons on the committees that are not at the annual meeting, they could go to work at once to prepare for their particular report, and in that way a full report could be got out at an early date and in this way a great deal of work could be saved to the chairman of the committee.

Mr. Bowen—Mr. Chairman: While this all seems very well, I think we

ought to recognize one fact: that our secretary in years past has been in the habit of performing his duties gratuitously, and while this may be a good idea, we are adding considerably more work to that individual, for which he gets nothing. I don't think we ought to do that, unless some good reason can be assigned why it ought to be done. Now, in forming these committees it has been the custom for years past for the president, in making up the committees, to consult the members before the committee was definitely made up, and get their consent to act, especially as chairman of the committees—get the consent of all of them. Now, in doing this, all the members of the committee certainly know that it is desired to have them on the committee, and when they are appointed they certainly know it. They may forget it. but if the idea of having the report brought out at an early day is carried out and the committees are in the report, that certainly brings it to their attention early enough. If it comes out in March that is quite soon enough, and the idea of the secretary being required to get up and send out special notices to the committees I think is giving him more work than is necessary.

Mr. Cully—It strikes me, Mr. Chairman, that it would not be very much work for the secretary to send out a postal card to the chairmen of the several committees.

Mr. Wickenden—I don't think Mr. Bowen just gets the idea I had in my mind, which was more particularly that the list of committees, which may be included in the annual report, might also with profit be separated, so that it could be preserved separate, or be carried, perhaps, in the pocket if desired, for the reason that if we had the interest of the society in our mind we might be able to keep the list of committees before us, and if desirable, or necessary, correspond with them from time to time, when the report might be in our library and we might overlook that.

Mr. Bowen—While we are on the subject of the report, it would probably be well to decide, if we can, about this directory. Now, the first thing to be determined is, how is it to be compiled? What will be the probable expense of it, and if it is to be an additional expense whether there is any fee to be charged for enrolling a name in this directory or not, or whether there is any idea or estimate to be made as to what the additional cost would be? I fear, however, that whatever we may decide upon in this particular, it will delay the publication of the report. If we undertake to get a response from all the engineers in the State in order to enroll them in that directory, I think probably that there will be some who would be quite tardy in sending in their order. I think all this should be considered and decided upon, so that the secretary will know how to proceed in the matter.

Mr. Davisson—I think this was brought up several years ago and the request was made in this way, that some one present from each county, who was a member of the society or known in the county, get them to furnish a list of all the names to the secretary. I know that was done and I remember we had it in one of the reports. I forget which report it was, but it was done something like five or six years ago. I don't see why that could

not be done now, and if there are members from the different counties here they could furnish these names without any further delay.

Mr Hoover—I have been listening to this discussion for some time, and while I read in the good book that it is more blessed to give than to receive, I am rather of the opinion that we members who come here and join this society and spend our money and time and use our efforts to promote the good of the engineering business and surveying of the State of Ohio, that if there is any gratis advertising to be done in our reports for anybody, that we are the gentlemen that are going to be benefitted by it first, and I don't know that I shall run around over Tuscarawas county, and part of Coshocton, to hunt up names and insert them in any directory that this society may see fit to print. I don t really see any propriety in doing so. Another book has said, "Be true unto yourself, and it follows, as day the night, that you cannot be false to anyone."

Mr. Bowen—Now, it follows, that if all this thing was to be done gratuitously, Mr. Hoover is exactly right, but if it could be done as a matter of business, and would be any relief to the financial part of our society, then it might be well enough to look to it.

The Chair—Gentlemen, are there any further remarks to be made upon the suggestions that you have made? If not, we have finished the programme of this afternoon. It is now about 10 o'clock.

Mr. Hoover—I would remark that, as chairman of the committee of the code, if the secretary would read the names of the brethren that compose that committee, Brother Holl is one of them, he and myself will be at the American House in the morning, and meet the committee and make our report if we can get together a majority of them

At this point the secretary read the list of the committee on code.

Mr Hoover—Brother Holl and myself will be at the American House in the morning in the back part of the officce, ready and primed for anything that may be laid before us.

Mr Wickenden—Mr. Chairman, I had supposed, until a few moments ago, that our secretary, upon whom must necessarily devolve a very large amount of labor, received some compensation I believe he did a few years ago. I don't know whether it was ever paid or not. It seems to me it would be a question that the trustees might well discuss whether that should not be renewed, even if it is required that the members should pay a little more annual assessment. I don t think we should require any man to give of his time, labor and ability, to compile such a book as our annual report, corresponding with the various similar societies of other states to attend to the distribution of such a number of reports as we have had during the past year for nothing I don t know how the rest of the members would feel, but I would be willing to pay my share of the cost.

A member—I don t know as I would be quite as selfish in that matter as Mr Hoover has been, and I think it would be a good idea to make this kind of a suggestion, that if the secretary of this society whoever he may be, if Mr Griggs for another year, finds that the finances are such that a directory

of that kind can be published. let him exercise his own judgment in the matter. I, for my part, think it would be a good thing, and I think he could notify some one member in each county in the State, or, as was said a moment ago, let the members in the different counties who are here give the names from that county.

Mr. Nicholson—Mr. President, I would make a motion to that effect, that the secretary be directed to compile a directory and publish it, if, in his judgment, he thinks the finances of the society will stand it.

A Member—I second the motion.

Mr. Bowen—Mr. Chairman: Before taking a vote upon that, I would like to amend that motion by first permitting the secretary to make a charge for his own services and pay himself what it is fairly worth, in the judgment of the trustees, and then if there is any surplus left devote it to this outside missionary work.

Mr. Hoover—And then try to assess it on those fellows who never pay a cent.

Secretary Griggs—In regard to the expenses of a directory, it seems to me that that would be very little, as I suppose it would be published in the annual report with the names of the members. In some of the reports which have been published I think a list is contained of all the engineers and surveyors in the State, and a star opposite the names of those who were members of the society, and a note to indicate that that is the fact, and the work of compiling this, if the members would take it up, if they thought best to do it, would not be very much, because they would do the work. Of course, some names would be duplicated if all the members took an active interest in it, but they could be separated and the name inserted but once, and it would only cost, with the balance of the report, one dollar per page. That would be, substantially, all the expense connected with it—the additional pages it took in the report and some little time for the secretary. In regard to the finances of the society, if the secretary properly attends to his duties and solicits advertisements, a very good class of advertisements can be obtained. The labor of the secretary is considerable. I do not regret anything that I have done for the society this year; it has been somewhat of a pleasure in some respects. I have made a good many acquaintances that I consider valuable, and I have had the hearty assistance and co-operation of some of the members, nearly all, as far as they were called upon, and the duties have been lighter in that respect. I wish to take this occasion to thank the members of the society for their co-operation, and it might be proper, and I think it would be another year, to have a salaried secretary; but inasmuch as my predecessors have served without pay, I prefer to do so this time, and I am not a candidate for re-election, as you know my duties will not permit me to attempt it for another year.

A Member—I second the amendment of Mr. Bowen.

Mr. Wickenden—Perhaps that can be stated so that I can understand it a little better. Mr. Bowen, will you make that statement again?

Mr. Bowen—Will the gentleman please state his motion again.

Mr. Nicholson—My motion was that the secretary be instructed to compile a directory of the engineers and surveyors of the State of Ohio, if in his judgment he thinks the finances of the society would stand it.

Mr. Bowen—My motion was to this effect, if I remember it rightly, that the secretary first make out a bill for his own services and pay himself what they are justly worth, in the judgment of the trustees, and then if there is any money in the treasury to devote it to outside missionary work.

Prof. Brown—I wish to second Mr. Bowen's amendment, and I know from experience some of the work about the secretaryship. I tried to do it for two years, and I served without salary, as Mr. Griggs has. The first year I was secretary we published the eighth annual report, I believe. It was a very large one. That was the first one I undertook.

Secretary Griggs—It was the ninth.

Prof. Brown—The ninth, very well. And it was the largest one we ever published, containing a number of cuts. It was a very expensive report, and a very good one. Mr. Thompson and Mr. Jennings had worked up the material, and all I had to do was to get it in shape and publish it. But the work of the secretary is much greater than the majority of the members think it is. There is lots of work about it, and I don't think a man should be asked to do it for nothing, especially a man who is in active practice and whose time and every power is worth money, and I think with Mr. Bowen that we ought first to pay our secretary and then do this outside missionary work.

Mr. Cully—There is a good deal said about the outside missionary work, as though it were quite a financial problem. Now, I anticipate that the amount of work necessary to get up this directory is not considerable. The secretary could have a number of postal cards, enough to cover the membership of this society, and mail them to the members and have them return within a reasonable length of time the names of all the surveyors that they know of, not already members of the society, and this list could be compiled in alphabetical order. It strikes me that this is not a very considerable amount of work. Of course we all recognize the fact that the secretary's position is not an easy one.

The question then coming up, on the motion of Mr. Bowen, it was carried.

The question then being upon the amendment of Mr. Nicholson, as amended, it was also carried.

The Chair—What is your further pleasure to-night? If there is nothing further, a motion to adjourn will be in order.

A Member—Mr. Chairman, I move we adjourn. The motion being seconded, was carried.

President's Address.

Members of the Ohio Society of Surveyors and Civil Engineers.

GENTLEMEN: It is my duty and pleasure to welcome you here to-day, at this the twelfth annual meeting of our society.

You have again assembled to hear an account of the work during the past year, to exchange fraternal greetings, compare notes, discuss matters of interest that will be introduced by the chairmen of the standing committees, and various papers of the society, and store up useful knowledge for future use.

The reports in detail of the secretary and treasurer present to you in the fullest manner all the facts which are essential to a perfect knowledge of the past year's operations, and they show a most encouraging state of affairs.

Few societies or corporations that are inaugurated ever fulfill the expectations of their founders, but the Ohio Society of Surveyors and Civil Engineers, as organized and vitalized, presents this remarkable anomaly of having achieved a permanent success which surpasses the expectations of its founders.

When we look back and trace the history of this society, with its small beginning in this city in 1880, we find ample reason for congratulations at the result of our labors, and in the happy circnmstances that have attended the meetings.

In all that period of eleven years, some of us now present have been favored to work harmoniously together, with not an adverse word to disturb the pleasures of our intercourse, and we may refer with satisfaction to the results of our efforts, thus advancing the cause of the profession among our fellows.

I propose, in this brief address, to say something of a profession to which the most of my life has been devoted—and I may have some difficulty in making it interesting; but I have chosen it because it is a subject I ought to be more familiar with than any other. I propose to say something on its origin, its work and kindred topics.

Rapid as has been the growth of knowledge and skill, as applied to the art of the engineer during the last century, we must, if we would trace its origin, seek far back among the earliest evidences of civilization. In early times, when settled communities were few and isolated, the opportunities for the interchange of knowledge were scanty or wanting altogether. Often the slowly accumulated results of the experience of the wisest heads and the most skillful hands of a community were lost in its downfall. Inventions of one period were lost and found again. Many a patient investigator has puzzled his brain in trying to solve a problem which had yielded to a more fortunate laborer in the same field some centuries before.

The Egyptians had a knowledge of metallurgy, much of which was lost

during the years of decline which followed the golden age of their civilization. The art of casting bronze over iron was known to the Assyrians, though it has only lately been introduced into modern metallurgy, and patents were granted in 1609 for processes connected with the manufacture of glass, which had been practiced centuriess before.

Again and again engineers, as well as others, have made mistakes from not knowing what those had done who had gone centuries before, and have had the same difficulties to contend with. In the long discussion which took place as to the practicability of making the Suez canal, an early objection was brought against it that there was a difference of level of thirty-two and one-half feet from the level of the Red sea and that of the Mediterranean. Laplace at once declared that such could not be the case, for the mean level of the sea was the same on all parts of the globe. Centuries before the time of Laplace the same objection had been raised against a project for joining the waters of these two seas. According to the old Greek and Roman historians, it was a fear of flooding Egypt with the waters of the Red sea that made Darius, and in later times Ptolemy, hesitate to open the canal between Suez and the Nile. Yet the canal was made and in use some centuries before the time of Darius. Strabo tells us that the same objection was made by his engineers to Demetrius, who wished to cut a canal through the Isthmus of Corinth some two thousand years ago. But Strabo dismissed at once this idea of a difference of level, agreeing with Archimedes that the force of gravity spreads the sea equally over the earth.

It has frequently been ascertained, though apparently with little truth, that the science of geometry and surveying was first cultivated in Egypt, in reference to measurements of the land, to recover and perpetuate the landmarks annually destroyed by the inundation of the Nile, a river said to overflow the greater part, if not the whole of the Egyptian delta, a tract of alluvial land numbering millions of acres, and upon which the proud river leaves a thin scale of mud every year, which mud it brings from the wash of the mountain streams of southern and central Africa.

Thales, of Miletus, who lived about 600 B. C., is among the first concerning whose attainments in mathematical knowledge we have any authentic information. About two centuries later the Platonic school was founded, which event is one of the most memorable epochs in the history of surveying. Its founder, Plato, made several important discoveries in mathematics, which he considered the chief of sciences. A celebrated school, in which great improvement was made in geometry, was established about 300 B. C. To this school the celebrated Euclid belonged.

Could we, in these days, summon the shades of Plato, Eudoxus and Euclid, and demand of them an answer to such questions as our subject suggests, with what rapture would we listen to the storied legends and strange traditions regarding primeval man! How eagerly and how gratefully we would drink in Egypt's ancient story, as understood, and current, when they were studying philosophy under priestly masters on the banks of the Nile, and in the marble halls of Heliopolis, or, perhaps, beneath the massive

pillars of the very Temple of the Sun, where now stands that single lonely obelisk, mournfully telling the wondering on-looker, the pilgrim from far-off lands, that "Once upon a time a mighty city had there stood, and marvelous things been taught."

What wonderful achievements have been performed in the arts of engineering, and what changes have been produced in other branches of business within the last century. Here is a region where once dwelt two widely-separated races—types of two epochs and two social conditions equally far apart. On the one hand is the dusky Indian, with the forest and prairie for his scene of action, the bow and the tomahawk, the bark canoe and the snow shoe, the wigwam and the painted skin, the pipe and the string of wampum for his sole wealth, protection, shelter and ornament. On the other hand, an entirely different race, with all the appliances of civilization. Between these great extremes there is nothing intermediate. The palace displaces the wigwam, the steamer the canoe, the railroad the narrow trail. Antiquity and To-day sit side by side. For the red man there is no history—what he is now he was of old. But there must be a history of civilization, for it is a growth—the expression and result of a long and eventful struggle. Yet there are no traces of this struggle or this growth,

The first essential qualification of the surveyor is to become conversant with the mathematical rules for the accurate solution of the various problems that may arise in his practice, and next to understand the legal requirements as adopted by the government and established by the courts, so that what work he may do, will stand the test in litigation and of those who may be called upon to inspect his work. We must keep abreast of the times, should read engineering journals for new ideas and attend our annual meetings for fresh inspiration. No one will deny that we have ample room for improvement. Let us then all unite and carry on the good work to elevate our standard of practice, and use every effort to attain that standard. It may be well to consider for a moment what elevating our calling means: Higher art, broader views, honorable and strict integrity in all our dealings. In our calling, as in all others, breach of professional courtesy should not be tolerated. He who violates this unwritten law of honor never has the trustful esteem of other members of the profession, nor the full confidence of those whom he serves. We should educate the young men who are to succeed us in this business. As we train the young men and boys in our employ, so, in a great measure, they will conduct the future business. Therefore, we should be careful to start right. To be a successful engineer a young man should have a good education, and in addition he should have a taste for the profession. This, combined with a good business training and strict application will produce the desired result in most instances; but not in all, for in one sense engineers, like poets, are born, not made. And here I would like to give a word of advice to the young man who wishes to engage in the business: The engineer's path is not all roses without thorns; neither can you be a successfnl engineer without hard work, perseverance and strict application to business. Very many young men of to-day think

they would like to go into the business because it is nice, easy work, soon learned and lots of money to be made. There can be no greater mistake; to learn the business requires a life-time study. An old friend said to me that he had been over fifty years at the business, but was only an apprentice yet.

In conclusion, I desire to say that to your laborious, earnest and faithful secretary much of the year's success is due. There are a number of important papers and reports that will be presented for discussion during the meeting, in which I trust you will all take part. I will, therefore, not detain you longer. I thank you for your attention.

Report of Board of Trustees.

To the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—The Board of Trustees of said Society would respectfully report that, in compliance with their duties, they have examined the books and accounts of the Treasurer and found them correct. We also fix the annual assessment per member for 1891 at three dollars.

Respectfully submitted

B. F. BOWEN,
C. N. BROWN.

Election of New Members.

The Secretary read the following names that had been proposed for membership:

J. W. Atkinson, Galion, Ohio.
O. Benson, Canton, Ohio.
William Dunn, Zanesville, Ohio.
Robert C. Gotwald, Springfield, Ohio.
George H. Hill, Milford, Ohio.
W. E. Myers, Ada. Ohio.
John S. Sill, Ashtabula, Ohio.
R. T. Walker, Troy, Ohio.

Upon motion duly made and passed, the secretary was instructed to cast the vote of the Society for the admission of the applicants above mentioned, which was done, and the above named persons declared elected to membership in the Society.

Vote of Thanks.

Upon motion of Mr. Wickenden a vote of thanks was tendered the retiring officers for the able manner in which they had conducted the affairs of the Society during the past year.

Election of Officers.

A nominating committee, consisting of Messrs. Judson, Wickenden and Pampel was appointed by President Buck, who proceeded to make their selection at once, and having done so the following report was read by Mr. Judson:

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN—Your committee, to which was referred the matter of reporting a list of names for officers for the coming year, respectfully submit this as their report:

For President—Thomas R. Wickenden, of Toledo.

For Vice President—Samuel Bachtell, of Columbus.

For Secretary-Treasurer—E. D. Wileman, of Massillon.

For Trustees—G. S. Innis, Columbus; J. B. Weddell, Galion; J. L. Cully, Cleveland; Julian Griggs, Columbus; R. A. Bryan, Portsmouth.

Respectfully submitted,

CHAS. A. JUDSON,
D. W. PAMPEL,
THOS. R. WICKENDEN,
(except as to president).

After reading the above report, Mr. Judson said: "Mr. Wickenden, of course, objected to being nominated for that office, but Mr. Pampel and myself voted him down."

Upon motion duly made and passed, the secretary was instructed to cast the vote of the society for the election of these officers; same was done, and the above named persons were declared duly elected to the designated offices for the ensuing year.

Time and Place or Thirteenth Annual Meeting.

The time and place of next meeting not having been decided at the last meeting, it will be suitably announced at some future period.

Report of Committee on Code.

To the Officers and Members of the Ohio Society of Surveyors and Civil Engineers:

The undersigned members of the Committee on Code beg leave to report that they have no alterations, additions or amendments to offer to the code. While they are of the opinion that the same could be added to in the shape of court decisions and rules of practice in the surveys of lands throughout the State. the subject would require more time and deeper research than your committee has been able to expend on that behalf.

Respectfully submitted,

O. H. Hoover,
John H. Holt.

Though not particularly relative, this report elicited the following statement from Mr. Connar, of Zanesville:

About a year ago, in looking at some papers in the auditor's office, or in the storage room of the garret of our court room, I found quite a bundle of surveys made by surveyors, and their surveys are scattered all over the State, some of the surveys north to the boundary line between Michigan and Ohio. I have never tabulated the papers, and they have never been recorded.

A Member—Did you find any relating to the Western Reserve or Cuyahoga county ?

Mr. Connar—I don't remember now.

Former Speaker—If you see any hereafter, I will be very grateful if you will let me know.

A Member—Wouldn't it be a good idea to deposit these in the State House ?

The Chair—This is a matter of great importance. I think it would be very well to look into it. I will say this. that in our county, the field notes of about twenty-five thousand acres never could be found. They are not in our county, and search has been made here at the State House and at Washington, and the supposition is that the notes that he refers to, some of the old government notes in Zanesville, are the ones, they have never been transferred, and I think it is worth while to look into it a little

Report of the Committee on Legislation.

The chairman of the above committee reported that there had been no report prepared, as there was nothing to report upon.

The society took the following action on pending legislation, to which its attention was called:

SIXTY-NINTH GENERAL ASSEMBLY, ADJOURNED SESSION.

S. B. No. 365.

MR. STEPHENS.

A Bill

To define what shall constitute a legal description of land.

SECTION 1. Be it enacted by the General Assembly of the State of Ohio, That each and every description of land in any instrument of writing hereafter executed, and which is to be placed on public record in the office of any county recorder in the State of Ohio, shall comply with the following conditions, viz.: It shall give the state, county, civil and surveyed township, range and section, if such there be, and if within a military survey the number thereof and boundary lines on all sides of the land described, with bearings and distances of each, and definite area.

SEC. 2. In any survey not less than three corners and not less than one-third of the total number of corners, shall each be fixed by some concise and stable monument more durable than a wooden stake, or by bearings and distances to two or more concise, durable and prominent objects, all of which shall be fully related in the description.

SEC. 3. All bearings in a description of land shall be given by the true (not magnetic) meridian, all distances in feet or chains, all areas in square feet or acres, all fractions shall be expressed in decimals, and all words, figures and signs shall be definite, plain and unmistakable.

SEC. 4. Each set of boundary lines used in a description shall close as a survey, so that the total error in either latitude or departure shall be less than three-thousandths (.003) of the sum of the lengths of all the lines.

SEC. 5. The exterior boundary lines of a recorded plat shall be complete as a description of a survey, and conform to all the requirements of sections 1, 2, 3 and 4 of this act. A reference to such a plat, or to a plat properly recorded before the passage of this act, giving number of lot with book and page of record shall constitute a legal description of a lot, and a concise delineation of a portion of a full lot described as above shall be legal for that portion.

SEC. 6. When a tract of land has remained unchanged in outline since its last transfer, the description by which it was last conveyed may be used if satisfactory to the grantee, in which case the words "old description used with consent of grantee" shall be appended to the old description.

SEC 7. If any proprietor or his agent shall sell any lot, lots or land, the description or plat of which does not conform to the provisions of this act, then such proprietor or agent shall forfeit and pay for each lot or tract of land so sold the sum of fifty dollars ($50), to be recovered with costs in a civil action in the name and for the use of the county, before any court of competent jurisdiction, at the suit of the county solicitor or any citizen of the county.

SEC. 8. It shall be the duty of any surveyor who furnishes a description or plat of any tract of land to accompany the same with a certificate that it complies in all respects with this act, and he shall then be responsible therefor, and for this certificate he shall be entitled to a fee not exceeding one dollar.

SEC. 9. A grantor or proprietor of a plat shall be liable to a grantee for all costs and expenses (including those of a civil suit) necessary to make a description or plat which shall conform to the provisions of this act.

SEC. 10. This act shall take effect from and after its passage.

The following resolution relating to senate bill 365 was presented.

Resolved, That the bill introduced by Mr. Stephens, entitled "To define what shall constitute a legal description of land" be approved and recommended for passage by the legislature, providing section 5 be amended so that the maximum error of closure shall not exceed 1 in 1,000.

After a spirited discussion, which was led by Mr. Hill, and participated in by Messrs. Griggs, Bowen, Bone, Wickenden, Burgess, Judson and Varney, the resolution was put to a vote and lost.

Prof. Brown then submitted a resolution approving and recommending the following bill:

SIXTY-NINTH GENERAL ASSEMBLY, ADJOURNED SESSION.

H. B. No. 1049.

MR. TAYLOR.

A Bill

To establish a uniform system of keeping time throughout the State of Ohio.

SECTION 1. Be it enacted by the General Assembly of the State of Ohio, That the lawful time of the State of Ohio shall be according to the reckoning of the system established and known as central standard time.

SEC. 2. This act shall take effect and be in force from and after the first day of April, 1891.

Some of you may, perhaps, remember Prof. Mendenhall's little talk last year in regard to the standard time of Ohio, in which he showed that Ohio has seventeen standard times. This is thought to be a disgrace to the State, and Mr. Taylor introduced this bill to help straighten this matter out. Therefore I move we endorse the ideas contained in this bill and hope it will be

passed and become a law, and that our action be placed before the legislature.

A Member—I second the motion.

The motion was then spiritedly discussed by Messrs. Varney, Griggs, Wickenden, Strawn and Mathewson and, being put to a vote, was carried.

Mr. Griggs—I have a resolution handed me to present that I will read:

Whereas, Governor Campbell, in his annual message to the legislature, called attention to the fact that Ohio stands twenty-sixth on the list of States in the aid she has given higher education, and

Whereas, Be it recommended that the State make an effort to elevate itself to its proper rank in this respect, and suggested that a tax of a fraction of a mill be levied on the taxable property of the State for the aid and support of the Ohio State University, and

Whereas, In pursuance of said recommendation, Mr. Hysell, speaker of the House of Representatives, has introduced a bill levying a tax of one-twentieth of a mill for that purpose, and

Whereas, Such a tax, amounting to only five cents on $1,000, would not be burdensome to anyone, but would enable the State to regain her proper place in the sisterhood of States, therefore be it

Resolved, By the Ohio Society of Surveyors and Civil Engineers, that we heartily approve said bill, and earnestly hope it may become a law, and further, that we particularly urge the members of the legislature from our respective counties to give it their support,

Mr. Strawn—Mr. President: I move that resolution be adopted as the sentiment of this association and that a certified copy of it be sent to the proper parties in the legislature. The motion, being seconded, was carried.

A member—In connection with that, I think there are a great many of us here who know but very little about the Ohio State University, and I think it will be very interesting to many of the members to have some history or statement in reference to that institution from Prof. Orton or Brown, if either is here.

Prof. Brown—I would not dare to speak when Prof. Orton is here. He can give the history.

Prof. Orton—I know the history, but it is a pretty long one. You remember the story of the minister whose Latin was a little rusty and he was invited to meet a gentleman from the other side of the water, a Hungarian, I think he was. He furbished up, after he found he was to meet this gentleman, one sentence, and he said, in Latin, "What was the history of the reformation in Hungary?" and he said that was his part of a two hours' conversation. The story went right along, and we might get into that same situation here. I wish, gentlemen, if it is possible for you, to adjourn and come up to the university for an hour. I wish it were possible for you to do so. I think we will manage to give you street car tickets to bring you up there and back, and if you can spend an hour we will show you what we are doing there and give you a much better idea than any amount of talking. If you will make that arrangement and name some hour to-morrow, it will not take

more than thirty minutes to go up and thirty to come back, and if you can spend an hour there we can show you a great deal of what we are trying to do. Of course, it would be a pleasure to me to explain the foundation and work of the university, but it would be a twice-told tale to many. I wish you could make that arrangement.

Mr. Strawn—I heartily hope that we may do that. I would ask that, if there is anything on the programme that could be brought in, that we might have it in to-night and give us an opportunity to close up the work to-morrow and also have the pleasure of accepting of this very kind invitation. Although we may not have any boys to send there, we are glad that others have boys to send there to attain a higher education than they will probably get if they didn't avail themselves of some institution of this kind. I have had the pleasure of speaking most heartily for this institution, and if I had some boys to send to school I certainly would patronize our own State institution.

The Chair—I would like to hear the sentiment of the society as to what their pleasure is in the matter of having some papers to-night.

A Member—I for one would be very glad to go to the university, and if we can transact any of the business that is assigned for to-morrow, I think it would be well to do so.

A Member—I understand that Mr. Wickenden has his report ready.

The Chair—The professor thinks about noon would be the best hour to go, if you conclude to go. Now, if we are a little expeditious and work a little later to-night, and perhaps get here a little earlier in the morning, and go up about noon, it would only take about two hours, and that would leave a chance for the most of us who have to go home to-morrow to leave, perhaps.

Prof. Orton—We have a civil engineering department, a mechanical engineering department and a mining engineering department. All of these are well equipped, and we have an electrical department. We have a very extensive chemical laboratory, as good as is to be found anywhere. If you have even an hour, that is a pretty short time, but you can learn a good deal in an hour. I should feel gratified if you could come up.

Mr. Wickenden—I move that the exercises to-morrow forenoon shall be closed at 11 o'clock city time to give us an opportunity to accept the very kind invitation of Prof. Orton.

The motion was seconded and carried.

Report of Committee on Civil Engineering.

We cannot hope in the short time given us to touch upon the work that is being done in the different branches of our profession. As we look back over the year's work we can see that much has been accomplished; we note improvement almost everywhere. Yet we are painfully aware of the fact that everything is not as it might be or as we would wish. We have made progress, and yet our condition, as a profession, is not what it should be. We have only to compare it with the status of the professions of the law or medicine to be certain that we have not realized our fondest hopes.

Efficiency in our calling requires the same amount of energy, of training, of study and research as in the others, and yet how different is our situation. The enterprising man in either law or medicine steadily rises in wealth and influence. He has many opportunities for promotion. He does not migrate annually, nor is he dependent upon a precarious salary as a means of livelihood. What is the reason for this difference? It is something like this: Both the lawyer and the doctor have made themselves essential (so it is believed, at any rate) to the well being of their fellow citizens. The one attends to the protection and disposition of our property. The other is just as essential to our health. In short, we cannot do without either in the ordinary pursuits of life.

The elevation of our profession lies along a similar line. We must make it just as essential to the welfare of man, if we would give it the standing it ought to have. How can we accomplish it? There are several directions in which we can move. We can improve the quality of our work. Those halcyon days when the compass and jacob staff could fill the native with an awe from which he seldom recovered, have passed away. We live in a more skeptical age. Our work must stand on its own merits; it must prove itself.

We can further advance by making our work practical, by adapting it to the needs of the times, by so combining theory with practice, that our work shall at all times be found suited to the purpose for which it was intended. It will be progress when our work shall be essential to the comforts of everyday life, i. e., so that buildings, for instance, shall not be erected until the sanitary appliances have been approved by the engineer; so that lands shall be drained only upon plans furnished by him; so that it shall be necessary that all boundary lines shall be monumented; so that all papers for the transfer of real estate shall first be submitted to him for his opinion.

It will be another long step forward when public improvements shall be made according to his plans and under his supervision, instead of being controlled by ignorant and often corrupt politicians. A strong point will have been gained when his services shall be recognized as so valuable to corporations that they cannot do without him; so that railway companies, for example, will see the wisdom of taking their general managers only from the

ranks of the civil engineers. These things cannot be brought about in a day, it is true, but we can at least set our faces in the right direction. We can improve ourselves by study, by making use of the best professional literature of the day, by observation and interchange of ideas. We can accomplish much by securing a law requiring certificates to be obtained before practicing and by securing the abolishment of that last vestige of compass worship, the office of county surveyor. We can use our influence to get the engineering department in towns and cities out of the reach of the politician. It is in these and other ways that will suggest themselves to you that we can hasten the coming of the better times for which we look.

As we glance over the field, we find much to encourage us, even during the past year. We find not only improvements in methods and appliances on the part of the engineer himself, but a growing desire on the part of the public to adopt and put in operation his advice and inventions. Particularly is this true in the direction of sanitary appliances. It is but a few years ago that water works and sewerage systems were comparatively unknown, except in large cities. Now there are few towns of a thousand inhabitants that have not one or both.

Permit us at this point to enlarge upon one feature of sanitary work.

The disposal of the sewerage of populous districts has been and is a serious problem in many sections of the country, especially so where towns and cities are located one above another on the same body of water, wherein health and life are endangered by sewerage pollution. Of late many attempts have been made to solve this vexed problem. The two favorable methods are cremation and chemical precipitation. We take pleasure in chronicling the fact that many gratifying results have been attained by both methods. The most interesting result in this line is the record of the Worcester (Mass.) Sewerage Disposal Works, completed and put in successful operation within the last year. Its process of purification consists in the introduction of chemicals into the crude sewerage, as the sewerage passes from the receiver. The receiver consists of a number of convenient sized bins or basins, through which the sewerage passes, depositing on the floor thereof the sludge or solid portion. On leaving the building line, sulphate of alumina, etc., is added, according as the sewerage is acid or alkaline, determined by litmus, or other methods, giving a clear, odorless effluent, so pure in result that it is said that it may be drank with impunity—though this process is not to be recommended as a good one for the production of pure water supply. The success of this plant, costing some $125,000, is said to be gratifying, both from a sanitary and from a financial point of view.

In this connection we would call the attention to the necessity for some improved method of cleaning the streets of the large towns, and the reckless, extravagant policy of street commission work. This work should be placed entirely in the hands of the city engineers, and the corporations should be divided into street cleaning districts and the work let annually to the lowest responsible bidder, under proper specifications, providing for cleaning the

whole district regularly and a specific number of times within an allotted time. Experience shows far better results at less expense on this than on the present wasteful plan.

CHAS. A. JUDSON,
JOHN L. CULLY.

A Member—I would like to ask Mr. Judson if he knows anything about the cost of that purifying process.

Mr. Judson—No, I could not state that. It is said to operate very nicely, though.

A Member—What is the method used to dispose of the slush?

Mr. Judson—That is drawn off and carted away, eventually to be used as fuel.

A Member—Not for manurial purposes?

Mr. Judson—No, sir.

A Member—Mr. Cully, haven't they got some work started or completed in Cleveland in regard to purifying the stream?

Mr. Cully—No; there have been several schemes agitated there. There has been a scheme of pumping the river out.

A Member—And let the water flow into the lake?

Mr. Cully—No. In the dry season, when there is the most trouble there, when the river gets low and is pretty well filled with sewage, then, of course, the atmosphere becomes contaminated, so much so that a person crossing the viaduct notices this very perceptibly. At that time of the year there are about ten million gallons of water coming in. Of course, if there is a plant put in, there would have to be ten million gallons pumped out. It is only a question of time, then, when the river would be filled with lake water, and that was the scheme proposed. The reason for its not being carried out was the cost. It was proposed to put a tunnel under the city and pump the sewage out of the river into this tunnel and carry the sewage out beyond the city east about seven miles.

A Member—That would involve making a tunnel under the lake.

Mr. Cully—No; they put the tunnel under the city and carry the sewer along the lake front beyond the city, so that the water supply would not be contaminated with the sewage. I think they have something like that at Milwaukee. They pump the fresh water from the lake into the river, I think.

A Member—Does anybody know what has been done in regard to the Cincinnati water supply in regard to improving the quality of that?

A Member—There has been nothing done only to provide two or three more pumps. Mr. Kirkwood, about '77, made a very thorough and exhaustive survey of Cincinnati, and devised a scheme, but it was sat down upon by the Cincinnati Commercial on account of its cost, which was four million dollars, and upon the urgency of the Cincinnati Commercial they got some new pumps. The little old water works built for a town of fifty thousand people is still doing duty. A commission was appointed about two years ago to examine into the matter and virtually adopted Mr. Kirkwood's plan, which was recommended again, and there it rests.

Report of Committee on Land Surveying.

During the year I sent out a series of questions, a copy of which is here given:

[EXHIBIT A.]

To the Members of the Ohio Society of Surveyors and Civil Engineers :

Your committee on land surveying would ask each of you to kindly give the information sought in the following questions as soon as convenient.

Address the Chairman,

J. D. VARNEY,
52 Public Square, Cleveland, O.

Question 1—What instruments do you use to measure angles and for alignment?

Ans. 1—Open sight compasss, compass with telescope surveyor's transit,

Erase those you do not use

Engineer's transit, manufactured by......of......

and add below description of any peculiarities of construction you think will be of interest, with your opinion as to merits.

I have used it since......before which time I used......

Ques. 2—To what extent do you depend on the needle for alignment and for measuring angles?

Ques. 3—What do you use for measuring distances?

Ans. 3—Wire chain......feet long, divided into.. ...feet......links.

Erase the one you do not use.

Band chain, steel tape, manufactured by......of......

Erase the one you do not use.

The ribbon is......wide and......thick.

Thickness can be easily measured by placing enough together to make an inch in thickness.

Ques. 4—What, in your opinion, are the relative merits of the chain, the band chain and the steel tape, taking into account accuracy of work, convenience in using and liability to breakage?

Ques. 5—What means, if any, do you use to secure uniformity of strain and to correct for temperature?

Ques. 6 and 7—Please state your opinion as to the relative number of chains, band chains and steel tapes used in your county. If your knowledge extends to more or less than your county, please give a like opinion as to the territory of which you have knowledge.

Ques. 8—Have you any problems as to the establishment of corners or lines that you wish to submit to this committee?

If so, please send with this, and at once, that we may have time to consider them before the meeting, which is to be held 20, 21 and 22 of January, 1891.

Ques 9—Will you kindly submit to us a report of a survey made by you during the past year?

We would like a plat, and to have shown, either on the plat or in accompanying notes, as best suits you, the methods used to overcome obstacles, your calculations for distances and angles not measured and the area, also your "error" and how you balanced.

On account of the labor in preparing this, we advise you to select a survey having but few sides.

Please show also your method of recording for future reference.

The object sought here was in the nature of an effort to take an account of stock to determine whether we are on an up or down grade in the quality of our work.

Thirty-five replies were received, showing as follows :

As to No. 1. Twenty-seven are using engineers' transits, four are using surveyors' transits, one is using a Gurley Light Mountain transit, one is using a compass with telescope sight, three are using open sight compasses, making four, and only four, who are depending on the needle for angles. Of those who are using transits, eight have changed from open sight compasses, two have changed from telescope compasses, one has changed from a railroad compass, one has changed from a surveyor's transit to a telescope compass, this being the only case of retrogression. The others all seem to be going in the right direction,

As to No. 2. Eighteen depend on the needle only, as a rough check on angles; nine do at times depend on it for alignment or angles, or both.

As to No. 3. An explanation is necessary here: In framing this question by "band chain" I meant that kind of steel tape which is divided only to feet or links, and by steel tape I meant those which are divided to fractions of an inch or to hundredths of a foot through the whole length. This name "band chain" seems to be improper, but the manufacturers so use it, and I supposed the term would be understood, but I was mistaken, for the answers speak of using steel tapes made by Sager and others who manufacture only "band chains." Taking the evident meaning of the answers it appears that twenty-five are using "band chains," twenty are using steel tapes, three are using wire chains, two are using wooden rods for very accurate work. Of these eleven use the "band chain" exclusively, five use the steel tape exclusively, not one uses the wire chain exclusively. The three who report the use of it here have also "band chains" for all except coarse work.

As to No. 4. The opinions of the relative merits of the different tools are correctly foreshadowed in the answers to No. 3. For accurate work one person prefers a wooden rod to either of the others.

As to No. 5. Six persons in part or all of their practice use spring balances to help secure uniformity of strain, and thermometers to correct for temperature, but a large majority think their work does not demand this.

As to Nos. 6 and 7. The answers indicate that about the same practice exists outside as among members; though in two instances the statement is made that all the other surveyors in their respective counties use only the chain.

As to No. 3. The following problems were received

BY E. D. WILEMAN.

About the only thing in the shape of a problem that my work has encountered lately is where I am occasionally asked to start at the end of an old mine survey where only one point has been preserved, top and bottom, and to extend the survey accurately.

BY J. T. BUCK.

DESCRIPTION OF DEED FROM FROM GUIAN CLEMENTS AND MARGARET CLEMENTS TO JOHN THROCKMORTON.

"Being a *clover field* in the northeast corner of the lands sold by Hiram Westbrook to Guian Clements, and bounded on the north by lands sold by Herman Martin to said Clements, and on the east by lands owned by said Martin, supposed to contain three acres of land."

The deed was executed about forty years ago. We hunted for the *clover field*, but could not identify it, the number of lot, section, township and range being omitted. At last an old pioneer came to our relief and located it, now in the middle of a farm which had surrounded it. The clover had disappeared, and thistles and briers grew thereon.

I cite the above case to show the incompetency of some officials clothed with the authority to draw and acknowledge instruments of conveyance.

The foregoing appear to have been submitted to illustrate the absurd demands made upon us, rather than with a view to having a solution given.

BY L. W. MATHEWSON.

Fig. A.

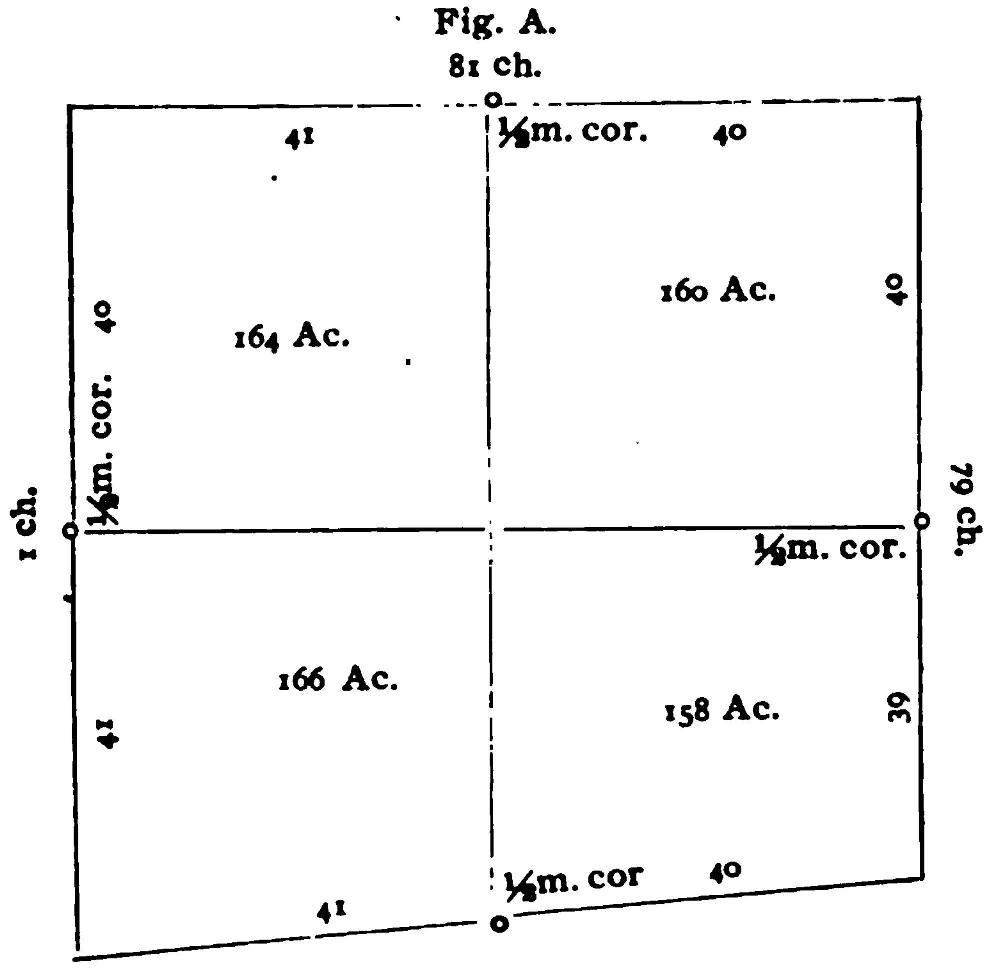
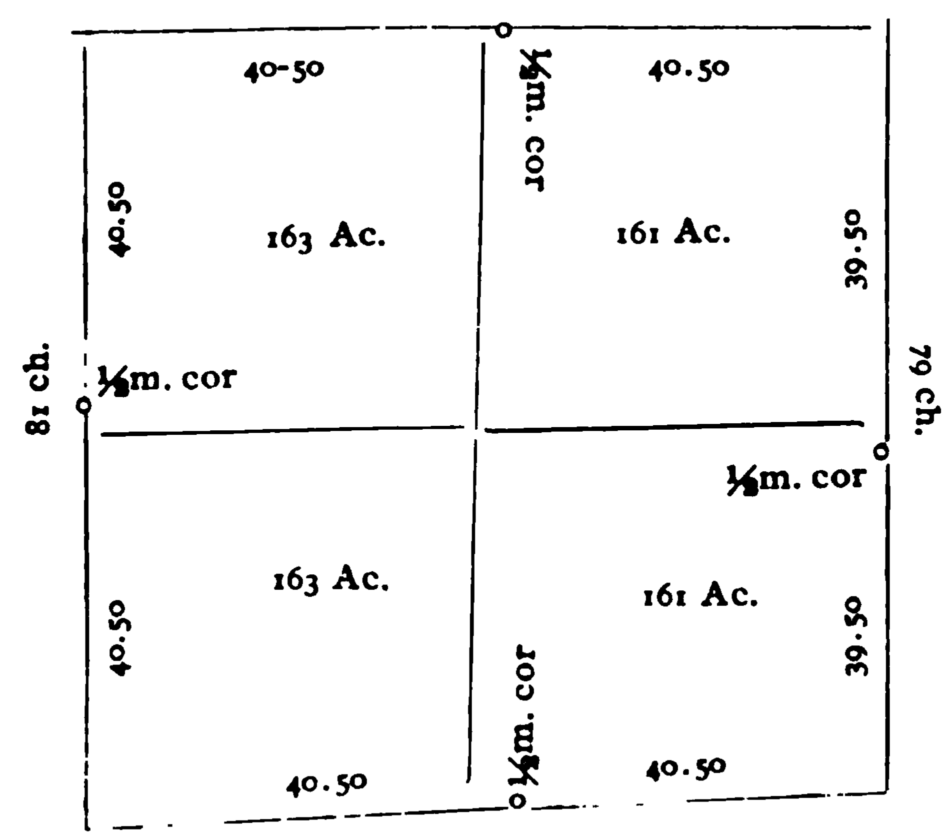


FIG. B.



In a certain state where U. S. surveys were made, half-mile stakes were set. There was no uniformity about which direction measurements were made Sometimes they were from North to South, and again from S. to N. Sometimes from East to West, and again from W. to E.

These half-mile stakes were not set half way between section corners, but were set at 40 chains from the section corner from which measurement happened to start.

The quantity of land in each section, as given by the U. S. field notes, was found by multiplying one-half the sum of north and south lines by one-half the sum of the east and west lines. In selling off the quarters, half quarters or quarter quarters, the U. S. patents call for *exact* fourths, eighths or sixteenths of the total area. For example, in the section shown above, the area is 648 acres. U. S. patents call for each quarter section as 162.00 acres. If quarter lines are run as per Figure A between half-mile corners, southwest quarter will have 8 acres more than southeast quarter. If run as per Figure B, to points equi-distant from section corners, there is still a difference of 2 acres in quarter section areas.

Should quarter lines be run as per Figure A or B, or should they be so located as to divide the section into exact fourths?

This is a peculiar case where it appears that the survey by the government engineers was not made in accordance with any known instructions by the government, and it is quite a grave question what to do about it. Mr. F. M. Kennedy, of the committee, is of the opinion that the interior lines should be so run as to give equal areas for the smaller divisions. Mr. J. R. C. Brown, who has had large experience in government surveys, at my request submits the following opinion:

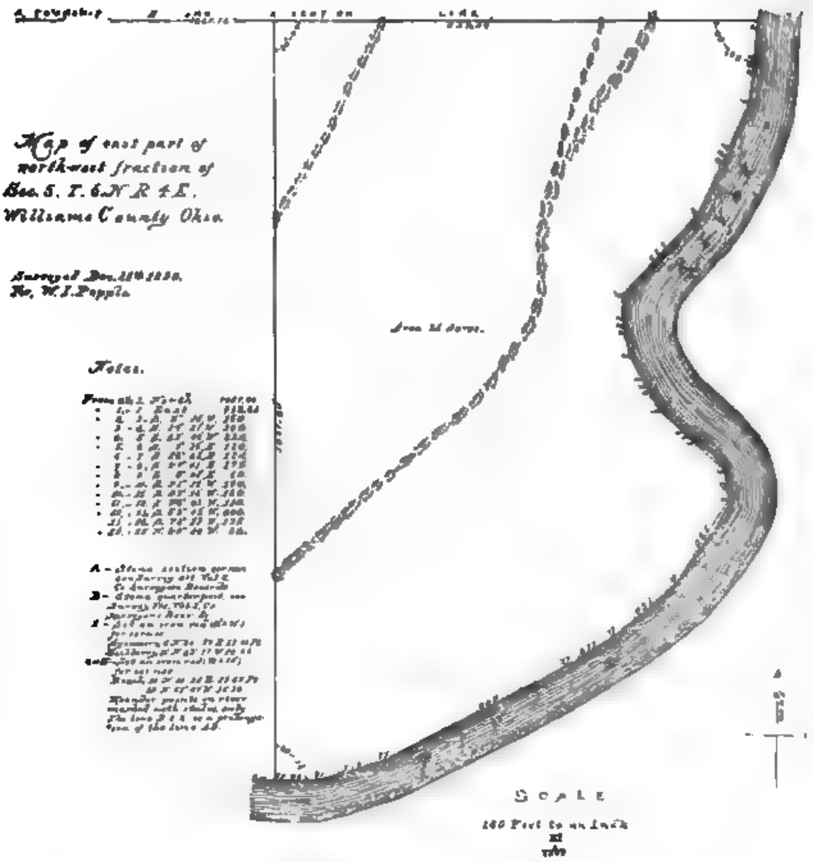
"In the figure "A" the section is divided as the government surveyors returned the notes, with distances as the returns show. The re-location of the quarter corners and the division of the section is required. The section corners are supposed to be in the proper position. The re-location of the "stake quarter section corners is the first step," viz.: re-measure the section lines, and divide the distance found into two parts, having the same ratio to each other, as the respective parts (as returned by government surveyors) of the original section line bear to each other; and at the point so determined fix the quarter section corners; then connect opposite quarter corners by straight lines, thus dividing the section into quarter sections, and fixing the center part of the section at the intersection of these lines. Second; find the center of each of the quarter section lines as made above, and connect opposite points by straight lines through the quarter sections. thus dividing the quarters into sixteenths, one-sixteenth section or lots of forty acres approximately. The area of the division of the quarter sections will be different in each quarter section; but quantity does not control; the rule for division must be followed, and the area of the several sixteenths will be as this division will determine. For the rule giving this case see Dun's Land Laws, p. 85, No 524."

J. R. C. Brown.

This problem seems to be of sufficient importance to warrant further study and discussion and we would suggest that the members send their opinion to the new committee.

Question 9 was asked hoping that different methods of work might be exhibited and with profit compared. Responses were received from Messrs. J. C. Grim, F. A. Bone, E. W. Dimock and J. D. Varney, as follows:

BY J. C. GRIM.



In proving or balancing the work, if my error is small, I distribute it where the error or errors are most likely to occur. If the error is large, I retrace the work on the ground and generally succeed in reducing it.

To pass an obstruction on a line, I offset (as short a distance as possible) and run on a parallel line when possible. To measure across an impassable river or pond, I make the most simple triangulation possible, and keep all notes and calculations and prove them in the office.

My record for future reference consists of my notes taken in the field. I keep topographical notes of each line run, then make a plat on a page of the field book of the entire survey.

JOHN C. GRIM.

PROOF AND COMPUTATION OF AREA.

Side.	Bearing.	Dist.	Cos.	Sin.	N.	S.	E.	W.	D. M. D.	N. Areas.	S. Areas.
0 to 1	North	1487.40	1.00000	.00000	1487.45						
1 to 2	East	939.24	.00070	1.00000			939.24		939.24		
2 to 3	S 5° 20′ W	160	.99567	.09295		159.31		14.87	1863.61		296891.61
3 to 4	S 24° 27′ W	240	.91032	.41390		218.48		99.34	1749.40		382208.91
4 to 5	S 43° 00′ W	220	.73135	.68200		160.90		150.04	1500.02		241353.22
5 to 6	S 7° 26′ E	120	.99160	.12937		118.99	15.52		1365.50		162480.84
6 to 7	S 28° 42′ E	120	.87715	.48022		105.26	57.62		1438.64		151431.25
7 to 8	S 47° 01′ E	175	.68179	.73155		119 31	128.02		1624.28		193792.85
8 to 9	S 8° 02′ E	60	.99019	.13975		59.41	8.37		1760.67		104601.40
9 to 10	S 32° 21′ W	190	.84480	.53509		160.51		101.67	1667.37		267629.56
10 to 11	S 49° 18′ W	160	.65210	.75813		104.34		121.30	1444.40		150708.70
11 to 12	S 58° 03′ W	110	.52918	.84851		58.21		93.34	1229.76		71584.33
12 to 13	S 62° 33′ W	400	.46097	.88741		183.49		354.96	781.46		144093.41
13 to 14	S 73° 13′ W	135	.28875	.95740		38.98		129.25	297.25		11586.81
14 to 15	N 89° 34′ W	84	.00756	.99997	.64			84.00	84.00	53.76	
	Error of angles from closing 0° 02′				1488.09	1488.09	1148.77	1148.77		53.76	2178362.89

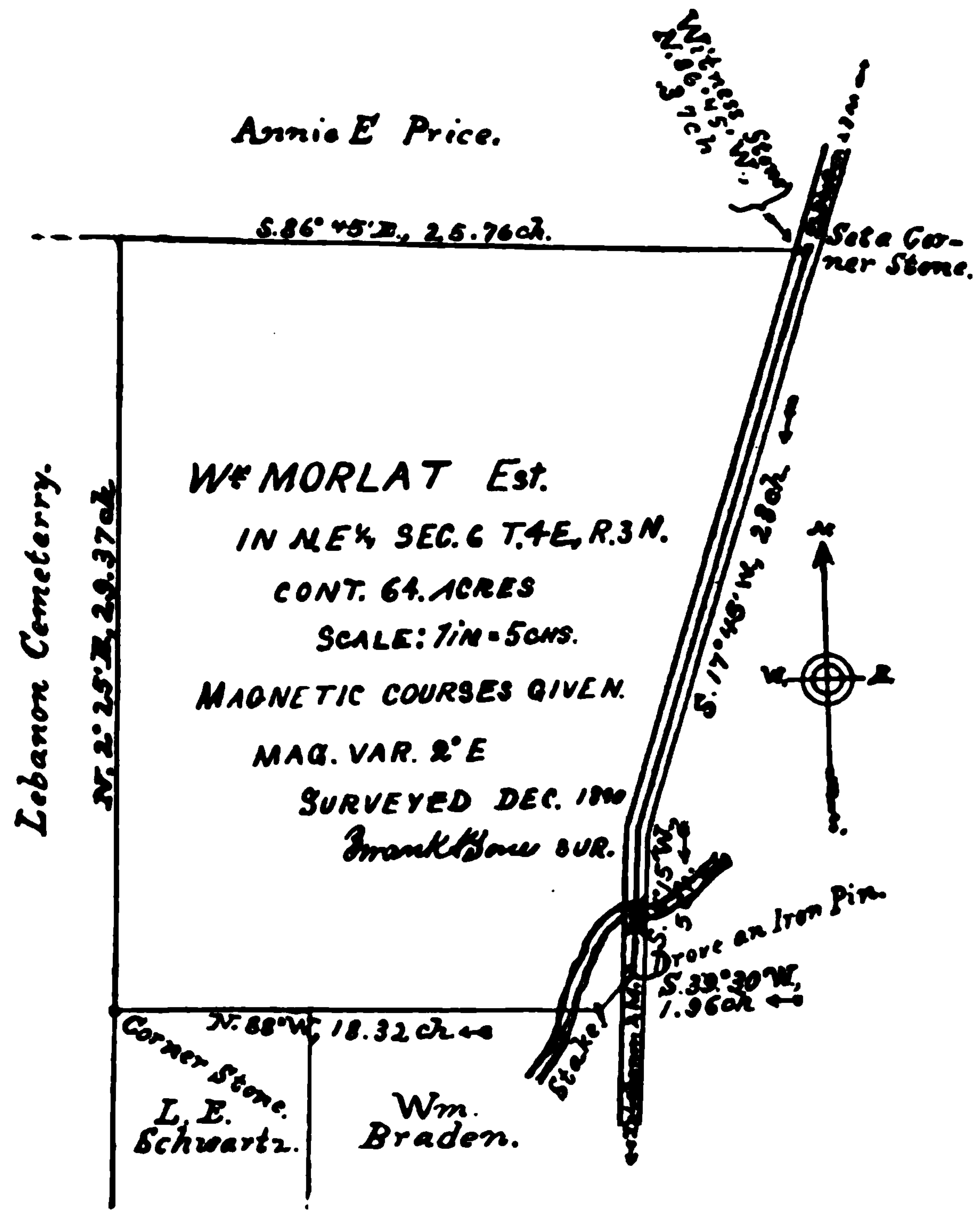
53.76

2)2178309.13

43560)1089154.56(25.00
87120

217954
217800

15456



SURVEYOR'S REPORT.

At the request of Lot Wright, attorney of Hepzibah Morlat, administratrix of the estate of Wm. Morlatt, deceased, I have made a survey of the real estate named in the foregoing petition, and submit the following description and plat of said survey:

DESCRIPTION.

Situated in the county of Warren and State of Ohio, being a part of the East ½ of Section 6, T. 4, R. 3, and beginning at a corner stone at the N. W. corner of the lot of L. E. Schwartz and in the East line of the cemetery; thence with said East line of the cemetery N. 2° 25' E., 29.37 chains to the N. E. corner of said cemetery; thence with the South line of Anna E. Price's land S. 86¾° E., 25.76 chains to a corner stone planted in the center of the Lebanon & Dayton pike and witnessed by a stone on the line N. 86¾° W. 37 links; thence with the centre of said pike, 1st S. 17¾° W., at chains; 2nd, S. 4¼° W., 5 chains to an iron pin in the middle of the pike; thence S. 39½° W., 1.96 chains to a stake; thence with the North line of Braden's and Schwartz's lots, N. 88° W., 18.32 chains to the place of beginning and containing 64 acres.

FRANK A. BONE,
Surveyor.

Dec. 1890.

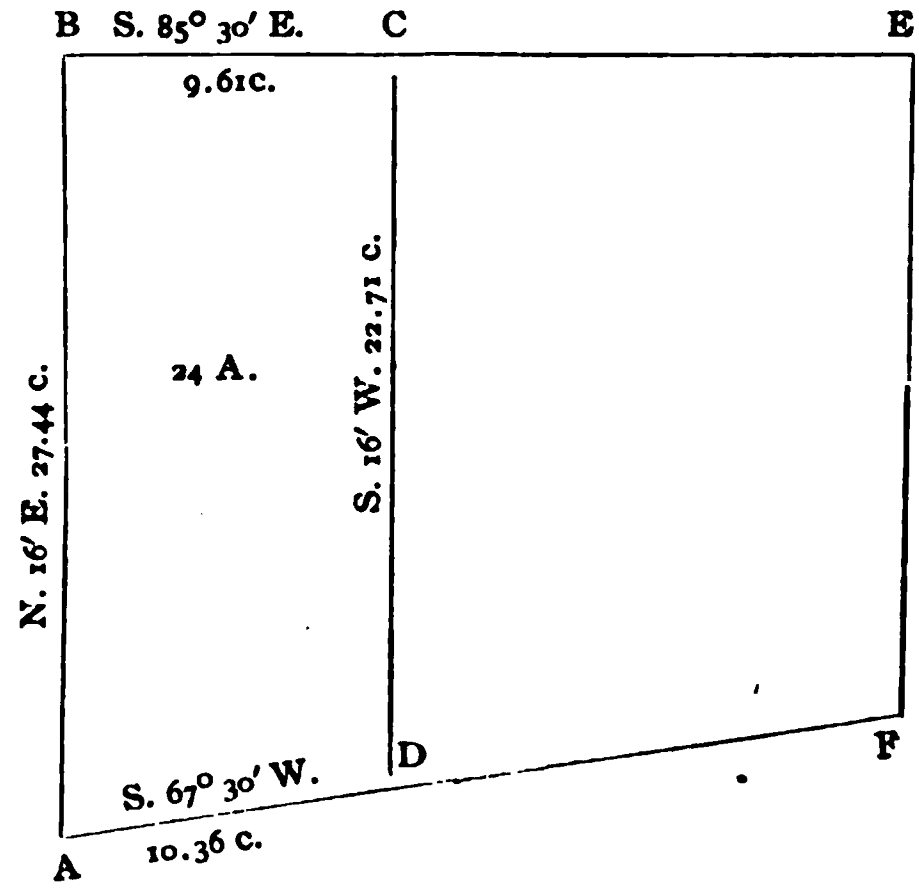
WM. MORLAT ESTATE (CALCULATIONS).

Sides.	BEARINGS.	DISTANCE	LATITUDES. N's.	LATITUDES. S's.	DEPARTURES. E's.	DEPARTURES. W's.	Cor. Lat.	Cor. Dep.	BALANCED. N's.	BALANCED. S's.	DOUBLE M. D.	NORTH A.	SOUTH A.
1	S. 30½° W.	1.96		1.51		1.25				1.51	16.03		24.2053
2	N. 88° W.	18.32	.64			18.31	+1		.65		35.59	23.1335	
3	N. 2° 25′ E.	29.37	29.35		1.23				29.35		52.67	1545.8645	
4	S. 86¾° E.	25.76		1.46	25.72		-1			1.45	25.72		37.2940
5	S. 17¾° W.	23.00		21.91		7.01	-1			21.90	7.01		153.5190
6	S. 4¼° W.	5.15		5.14		.38				5.14	14.40		74.0160
			29.99	30.02	26.95	26.95		.	30.00	30.00		1568.9980 289.0343	289.0343
												20) 1279.9637	
												63.998	

.77	.64	7.01—5	16.03	25.72
.74	.61	7.01	1.51	1.45
		.38		
1.51	1.25		16.03	12860
		14.40—6	8015	10288
.63	17.99	.38	1603	2572
.01	.32	1.25		
			24.2053	37.2940
.64	18.31	16.03—1		
		1.25	35.59	21.90
28.98	1.22	18.31	.65	7.01
.37	.01			
		35.59—2	17795	2190
29.35	1.23	18.31	21354	15330
24.96	1.42	53.90	23.1335	153.5190
.76	.04	1.23		
			52.67	14.40
25.42	1.46	52.67—3	29.35	5.14
		1.23		
4.99	.37		26335	5760
.15	.01	51.44	15801	1440
		25.72	47403	7200
5.14	.38		10534	
		25.72—4		74.0160
			1545.8645	

BY E. W. DIMOCK.

I am required to part off 24 acres of land on the west part of the tract shown in accompanying plat, on a line parallel with west boundary.



Ang. A	67°-14′
" B	88°-46′
" C	94°-14′
" D	112°-46′
	360°-00′

1. Let ABEF represent the tract, and AB the West side.

2. By the Survey Angle A = 68°-14′, B = 85°-46′ } Sum of Ang. A and B = 153° and 180°—153° = 27° = Supplement.

3. Sine Angle A = 9.96477′, " " B = 9.99881 } Product Sines A and B = 19.96358 = 1st Term.
" Supplement (27°) = 9.65705, Radius = 10. } Product = 19.66075 = - - - - - - 2nd Term.
Area to be cut off x 2 = 480 sq. ch. Log is - - 2.68124 = - - - - 3rd Term.

4. Multiplying 2nd & 3rd Terms = = 22.33829
5. Dividing by 1st 19.96358
Log = 2.31471 = 237.0 = 4th Term.

6. Now Sum of Angles A & B = 153°
and 180° > 153°,
Therefore, $AB^2 = (27.44^2) = 752.9536$
Subtract 4th Term 237.
515.9536

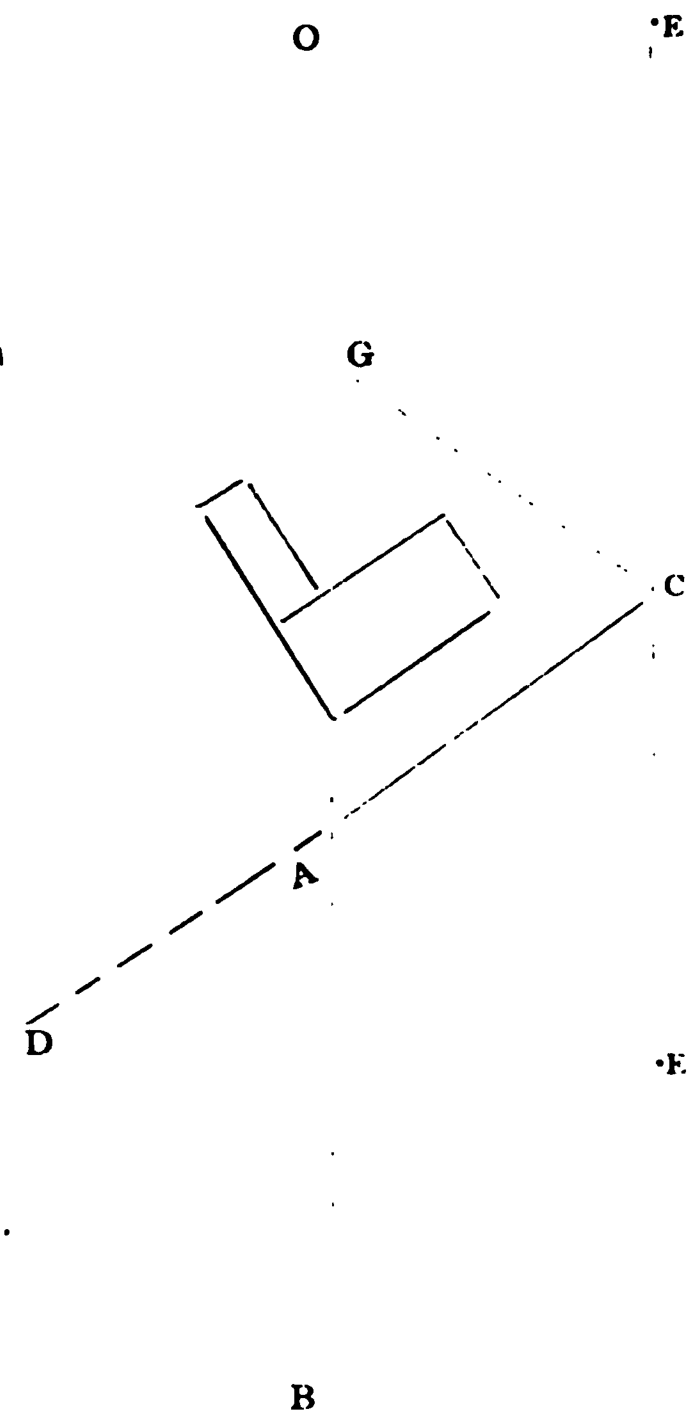
7. Extracting Sq. Root = 22.71 = DC

Then:
As Sin. Supplement (27°) 9.65705
: Sin. Angle B
:: Diff CD & AB : AD

Solution. Diff CD & AB = 4.73 = Log. 0.67486
Sin. Ang. B = 9.99881
Multiplying - - - - 10.67367
Div. by 1st Term 9.65705
Log. 1.01662 = 10.39 = AD

BY E. W. DIMOCK.

TO PASS AN OBSTACLE IN LINE OF SURVEY, BY USE OF AN EQUILATERAL TRIANGLE.



1. With Inst. in adjustment to Line at A, turn off 60° on Limb to right, and measure a convenient distance to point C. Transit telescope and set rear flag D at a convenient distance.

2. Set Inst. on point C, and without unclamping Limb direct telescope to D.

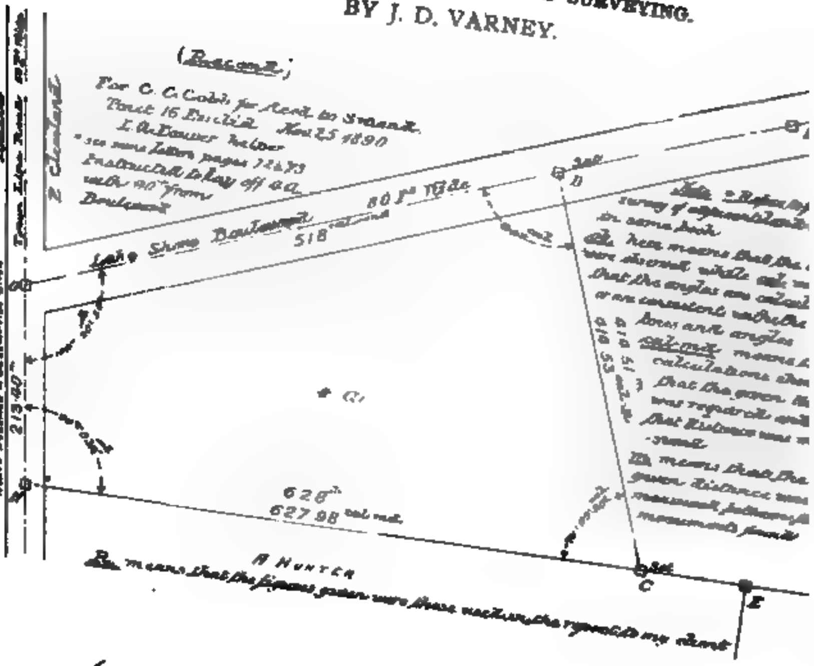
3. Turn off 60° from CD to left. The telescope will now have a range parallel to AB. Set rear flag at E and produce the parallel to a convenient distance, F, whence let fall a perpendicular upon the intercepted Line BAO.

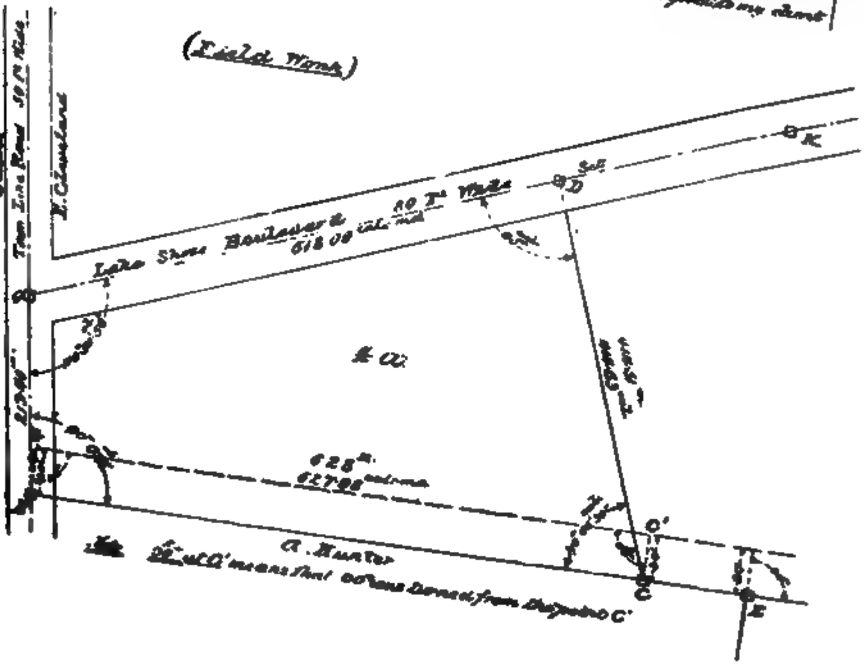
4. Turn off 60° from CF to left, and measure the distance CG AC. Set point G.

5. Set Inst. on point G, and without unclamping Limb direct telescope to C. Turn off 60° to right, and O should now fall in Line of Collimation.

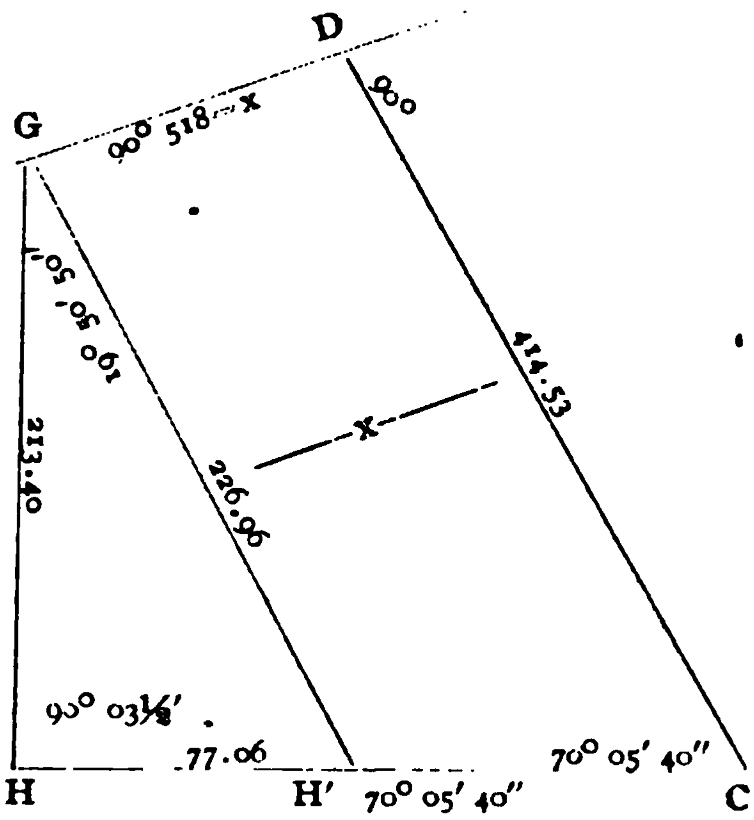
REPORT OF COMMITTEE ON LAND SURVEYING.

BY J. D. VARNEY.





FIELD CALCULATIONS.



Sin 70°-05'-40" a.c. 0.0267543
 " 19-50-50 - - 9.5308567
 213.40 - - - 2.3291944

HH'=77.0558 1.8868054

Sin 70°-05'-40" a.c. 0.0267543
 " {90-03-30 / 89-56-30} .. 9.9999998
 213.40 - - 2.3291944

GH'=226.959 2.3559485

$\frac{213.40 \times 77.06}{2}$ = 8222=GHH'

43560x4= 174240

166018=Required for GDCH'

Cot 70°-05'-40"=.3621041x(*x* assumed to be 600)=217.26
 226.96=GH'
 444.22—DC
 2)671.18=GH'+DC
 335.59x600=201364
 166018
 35336 too much
35336 divded by 444.22=80+

600—80=520 *x* 2d time.

(Let *x* =520)x3621041=188.29
 226.96
 415.25
 642.21=DC
 $\frac{642.21}{2}$x520=166975
 166018
 957 too much÷415.25=2+

518xCot 70°-05'-40"=187.57 520—2=518 *x* 3d time.
 226.96
 414.53=DC
 641.49
 $\frac{641.49}{2}$x518=166146
 166018
 126 [too much — near enough

$\frac{518}{\text{Sin } 70°\text{-}05'\text{-}40"}$=550.92=H'C
 77.06
 627.98=HC

Assume H'GD to have been other than 90°, say 88°; then
+Cot 70°-05'-40"=.3621041
-- " 88° =.0349208

+.3271833 to be used in place of .3621041

PROOF.

				L.	D.	D. M. D.	Areas +	Areas -
1	HG	North	213.40	+213.40		0.00	0.00	
2	GD	N 70°-09'-10" E	518.00	+175.87	4 +487.23	487.24	.9836	
3	DC	S 19°-50'-50" E	414.52	-389.91	+140.74	1115.22		4.9912
4	CH	N 89°-56'-30" W	627.98	+ .64	-627.98	627.98	.0046	
				+389.91 -389.91	+627.97 -627.98 -.01 +627.98 -627.98		.9882	4.9912 .9882 4.0030

		Cos.		Sin.
70°-50'-10"		9.5308567		9.9734056
518		2.7143298		2.7143298
	175.867+	2.1451865	487.231+	2.6877354
		671		40
		194		14
19°-50'-50"		9.9734056		9.5308567
414.53		2.6175560		2.6275660
	389.907+	2.5909616	140.738+	2.1484127
		532		
		84		
89°-56'-30"		7.0077941		
627.98		2.7979458		
	.63935	-1.8057399		

2) 175.87		2.2451918
487.24		2.6877429
		4.9329347
2A	..	4.9401179
.98359		-1.9928168
3) 389.91		2.5909644
1115.22		3.0473606
		5.6383250
2A	–	4.9401179
4.99122+		0.6982071
		50
		21
4) .64		1.8061800
627.98		2.7979458
		2.6041258
2A	–	4.9401179
.0046132		-3.6640079
1A = 43560 Log. 2	=	4.6390879
		.3010300
		4.9401179 = 2A used above

The answers from Prof. C. N. Brown deserve especial notice, because of his representative position as an educator. He has at the university three transits by Gurley which have been in use about eighteen years, one new Fauth transit, and one open-sight compass, over fifty years old. He teaches his students "that the needle is good only for very cheap lands and as a rough check on the vernier." He uses wire chain 66 and 100 feet long, divided to links and feet; also band chain by Sager and an Excelsior steel tape by Keuffel & Esser. He recommends only the band chain for ordinary work and the steel tape for city work, For strain he uses a steel balance, and for temperature a good thermometer. He uses Johnson's text books on surveying and teaches his methods of balancing and disposing of "error." He also pays considerable attention to stadia work and says his students get better results with it than with the chain.

On the whole, the responses to the series of questions are very gratifying as an indication of the practice among us and also among the other surveyors and engineers of the state who are not members.

Let us remember that in 1874 but few steel tapes were in use, even in the cities: that surveys were nearly all made with the chain, except where sufficient was at stake to warrant the use of wooden poles; that though by the poles, with careful handling, a very high degree of accuracy was attainable, (perhaps even higher than with the steel tape as claimed in some of the answers), they were too cumbersome to be used in general work. Remembering these things, the fact that the wire chain has now nearly gone out of use is evidence of an intelligently progressing spirit in the profession. My opinion is that when the advantages of the steel tape are fully appreciated, it is likely to be found that the use of the band chain is but a stepping-stone to the use of the steel tape for all purposes. It is to be hoped that in accordance with the usual course of things, this increased use of the steel tape will be at once a cause and effect of lower prices by the manufacturer.

An increased attention to strain and temperature is sure to follow the evident desire manifested to do a higher grade of work, and my own experience assures me that the time and trouble required for giving this attention is greatly overestimated.

DISCUSSION ON THE REPORT.

Mr. Varney—Referring to Mr. Dimock's method of passing an obstacle, I would like to know if others are in the habit of doing it that way.

Mr. Wileman—I turn as few degrees as possible to let me by an obstruction. If half a degree will let me by, I do that, and double the first in the second deflection, and the same as the first in the third.

Mr. Varney—I do not like that method. I think Mr. Grim's method is better.

Mr. Wileman—Where is the advantage of turning 60° or any other special number of degrees?

Mr. Varney—The advantage of 60° is that the distance on the true line is the same as the distance measured requiring no calculation.

Prof. Brown—With 60° you turn three angles, where otherwise you turn four.

Mr. Bowen—In practice would it not be better to choose any one of the different methods, according to circumstance? We meet conditions where it is not possible to turn 60° or any other specific number of degrees. We might be compelled to adopt Mr. Wileman's plan, one degree, two degrees, and one degree to get back.

Mr. Wileman—I can probably make the case a little clearer by citing the possible case of producing a line through the woods; a tree is encountered which it is desirable to pass with as little trouble as possible. It is very likely to be a difficult matter to choose a spot from which the 60° plan could be used without finding another tree in the road before the detour was completed. The square offset manner I do not like, because it takes excessively careful work to set four stakes and use them so accurately that the two lines shall be absolutely parallel, but by turning just enough to slide by the tree, using say 100 or 200 foot lines, there is no correction for distance necessary and only three stakes to set and center instead of eight.

A Member—Had we not better chop the trees down?

Mr. Wickenden—Mr. President, there is a tree over there (pointing to a lithograph of a very large gum tree in Victoria called "Uncle Sam") that I do not believe anyone would want chopped down.

Mr. Varney—We run lines to connect distant points. If the case demands that we keep as much as possible on the line on which we start, I prefer passing an obstacle by means of two 90° offsets, enabling me to prolong a line parallel with the required line a sufficient distance beyond the obstacle to enable me to get back by two 90° return offets, from which the line may be again continued. Such cases are rare, and with me have only occurred in city work.

In running a random I call the line from the start to the first obstacle the "true random." After deflecting to pass an obstacle, I make no effort to return to the "t. r." but fix points visible from each other and as near as I can by rough estimates and observations to the prolongation of the "t. r." Then by measuring the distances and observing the angles between these points it is easy to calculate the position of these points with reference to the "t. r." or to any other line or points to which measurements are made. The advantages of this method are a saving of time and in the fact that angles can be measured from given points with a much higher degree of accuracy than the angles can be turned.

Mr. Wileman—You speak of "keeping latitudes and departures each in one column only." Do you not think the chance for error in overlooking the signs outweighs the advantage of having only two columns?

Mr. Varney—I think not. Of course, there is greater liability to error, but the error is easily devoted. It is, of course, a little more mental strain.

Prof Brown I should like to say a word to call attention to the methods that Prof Johnson has given for balancing, in his excellent text book on surveying I like the book very much, and use it in one of my classes. It is especially adapted to engineers rather than to land surveyors, pure and simple. He gives in all four cases and four rules—two rules under one supposition and two under another He first supposes the survey to be made with compass and chain or tape, in which errors will be made in reading the angles as well as measuring distances. His second supposition is, that a transit is used and the angles measured and checked independently of the lengths of the sides, or that no errors are made in the angles, but all in the measurements of the sides. Under each of these suppositions he has two cases, viz 1st, in which all sides are equally difficult, or easy, to measure, 2nd, in which some sides are more difficult to measure than others.

Under the first supposition and first case he gives the ordinary rule, that is, error is distributed proportionately to the length of the sides, or

$$\text{Dist. around field} \quad \text{whole error in} \left\{ \begin{matrix} \text{Lat.} \\ \text{Dep} \end{matrix} \right\} \quad \text{Length of one side}$$

$$\text{error in} \left\{ \begin{matrix} \text{Lat.} \\ \text{Dep} \end{matrix} \right\} \text{in that side}$$

Under the second supposition and first case he distributes the error in Lat. (or Dep) proportionally to the Lat. of the side, or

Whole Lat (N + S) whole error in Lat. Lat. of one side error in Lat. in that side

Whole Dep (E + W) whole error in Dep. Dep of one side error in Dep. in that side.

Under the second case, where the sides are of unequal ease of measurement, he gives an opportunity for one to use his judgment as to where most of the error was made. Suppose we have a tract with some sides through smooth, level pasture land, very easy place to measure. We will call this one (1 Other sides are through brush and over uneven ground. It is more difficult to do good chaining here, we will say three times as hard. Other sides may be eight times as hard or two times as hard, etc , as the smooth, easy sides. We use our knowledge of the ground and our judgment in setting down these numbers, called "weights." Now to apply this method we proceed as follows Set the lengths of the sides in a column in order as surveyed. In another column to the right place these numbers expressing the relative difficultness of measurement. Johnson calls them "weights. Then in another column to the right place the product of each side by its "weight." Add these products. Then under the first supposition and case second we have

$$\left. \begin{matrix} \text{The } \textit{sum} \text{ of products} \\ \text{of sides by weights} \end{matrix} \right\} \quad \text{Total error in} \left\{ \begin{matrix} \text{Lat} \\ \text{Dep} \end{matrix} \right\} \quad \left\{ \begin{matrix} \text{The proപuct of} \\ \text{any one side} \\ \text{by its weight} \end{matrix} \right\}$$

$$\text{The error in} \left\{ \begin{matrix} \text{Lat.} \\ \text{Dep} \end{matrix} \right\} \text{in that side.}$$

Under the second supposition and case second he treats the Lats. and

Report of Committee on Highways.

To the President and Members of the Ohio Society:

GENTLEMEN: The regularly appointed chairman of this committee being absent from the state, the president, in October last, requested the writer to act. After consenting, communication was opened with the other members of the committee, with a view to preparing a report worthy of the importance of the subject under our care. Finding, however, that the remaining members of the committee were busy preparing matters for this convention or fully occupied with their professional duties, the report was abandoned, and in lieu thereof I desire to submit a somewhat hurriedly prepared paper, entitled "Engineers and Roads."

Respectfully submitted

THOS. R. WICKENDEN,
Chairman.

ENGINEERS AND ROADS.

BY T. R. WICKENDEN.

Of all the varied interests that effect the public and require, in a greater or less degree, the attention of our profession, the public highways are by far the most general, being used as they are by all citizens. In Ohio we have roads of all qualities between good and bad, both in city and village streets, as well as in the highways of the county and township; and the question arises, "What are and should be our relations to and influence over both the construction and maintenance of this very important branch of public work?" Are we not justified in claiming that in many cases the engineer is simply a mechanic and draftsman to carry out the ideas of men whose education and experience is entirely foreign to the problem of proper road construction and maintenance? It is a common expression, both of the press and the public, and is often used as an excuse and apology for bad roads, that we are not a nation of road builders, that we have not reached that condition in our national existence where good roads shall be the rule instead of the exception, and where the perfection of construction and maintenance of public highways often seen in the older countries shall be the custom and practice of our own. These statements contain much truth. It might, however, be said with equal truth that we are not a nation of engine builders, or a nation of bridge builders, or of construction of heavy ordnance, and yet it is true that some of the finest and most powerful engines are manufactured in the land; also that some of the most economical and boldest designs of bridges that the world has ever seen were born in the brain and constructed by the hand of American citizens, and to-day the old world looks on with admiration, if not with envy, at the finely finished and powerful guns now constructed in the factories of our land. And why? Because men of intelligence

and ability have given their best thought and exertions to bring about these various ends. And shall not the application of the same principles to the construction and care of our highways give equally good results?

It is a question that comes very near the public heart, for the reason that it draws very heavily on the public purse, and if the best results are to be obtained there must be intelligent designs, careful supervision of construction, and properly organized and directed forces for the maintenance of the same. With but a few exceptions these requirements are not found combined either in city, county or township, nor can they be until both the construction and maintenance of highways shall be placed under the care and direction of men whose training and experience specially fits them to have charge of and control, in a large measure, this department of public work. Such men I believe exist, and should be found in the greatest numbers in the engineering profession.

The construction of a street or road involves something more than filling up holes and covering up mud. The question of grades, width of roadway to be improved, cross section of completed road, drainage of both surface and sub-grade, the kind and amount of material to be used, should be submitted to a competent engineer for careful consideration and investigation, so that if he does not fully control and determine these questions he may give intelligent advice thereon. The preparation of plans, specifications and estimates should be wholly in the hands of the engineer, subject to the approval of the powers that be.

The work having been thus properly designed, it is even more important that he shall have full supervision of the work, in order that the details of the design may be properly and carefully carried out. It is not enough that he simply stake out the work, but he must have ample opportunity of seeing and knowing that the work is completed as laid out, and in this he will often find occasion to use competent assistants and honest, intelligent inspectors, who may be both hands and eyes to him, thus enabling him both to know of and control the carrying out of the entire work. When a road has been constructed and the work completed, it is usually supposed that the engineer's work is done. It should be in fact, simply commenced. Intelligent construction is but the beginning, and intelligent maintenance is of equal, if not greater importance. What would be thought of a man who should purchase or construct an expensive machine, whose various parts are liable to constant injury, if not properly cared for, and then turn it over to the care of a man having no knowledge of either its principles of construction or the care necessary to properly maintain it, and yet the public is spending millions of dollars on the construction of streets and roads which are subjected to the most severe use, and need constant and intelligent care, and then turning them over to men having neither theoretical nor practical knowledge of their needs, with the variation of a change of officers every few years with a usual result that in a comparatively short time the pavement or road is ruined and another large outlay needed. The old adage, "A stitch in time saves nine" is

specially applicable here, and none should be better fitted to know when and how to put in the stitch than the engineer.

What we need to remedy the defects here set forth is something of this kind: Each county divided up into proper districts, each in charge of an efficient engineer, who should control and direct all construction, care and maintenance of the roads of his district, and that the office of street commissioner in cities or villages either be abolished or made subject to the direction of the city engineer, so that all work on city streets, whether construction, cleaning or repairs, should be directed and controlled by the engineer; and the authority for granting permission to open or break into the streets, whether by officers of the city or corporations using the streets, should be vested solely in him, and proper provisions made and funds provided for the restoration of the streets broken into by forces directed by the engineer, the same forces being used to promptly repair any defects in the pavement or road as soon as they are discovered. One might then hope for and expect the best results for the monies expended, and the roads and streets of our nation might soon become a national pride rather than the disgrace many of them now are.

Report on Blanks and Instruments.

To the President and Members of the Ohio Society of Surveyors and Civil Engineers:

The display of instruments before the society consists principally of Keuffel & Esser Co.'s, as follows: A Y level with compass; an eighteen inch Y level, a small transit apparently as perfect in its parts as any of the larger instruments, with all the attachments, with a five-inch telescope and a two-inch needle; a plain engineer's transit with five-inch needle, with a very complete set of tangent screws pressing on a collar, which presses against the spindle, overcoming the old method of pressing on a point, also the leveling screws are fastened differently from the old methods, and they can be used without binding, as in most of the old instruments, where no screw is used to relieve the leveling screws; one light Mountain transit four-inch needle, with vertical limb, which has an extra plate laid in the center, the graduations being on this plate, avoiding the wearing of the graduations on the edges. The tripods of most of these instruments are of a new design and are firmly made. The extension tripod leg is of a novel design and can be made to suit the situation very quickly; a full assortment of the different styles of

excelsior, steel and metallic tape lines, also a line of band chains varying from one-eighth to one-fourth inch in width and are strong, well made and durable. The old surveyors' chain was on hands, but is becoming of interest only as a thing of the past.

The Paragon scales are very complete in their manufacture. They are inlaid on the edges with white composition with black figures, and are made in flat and triangular scales in all divisions, also a full line of draughting instruments of the highest grade, a surveyor's compass with three and one-half inch needle, and a small sight compass with clinometer, complete the field instruments. Two anamometers, one reading to 10,000,000 feet, and are very ingenious and novel instruments, Locke's hand levels, and Abney's reflecting levels, the Philadelphia rod, with Thompson's improved leveling targent, have some interesting features in their construction.

The liquid indelible drawing ink made by the above company in all colors is among the best in the market. Samples of their Helios blue print paper, Nigrosine black print paper, also of their drawing, profile and cross section papers were on exhibition. An engineer's slide rule, divided on celluloid facing, used for calculating, completes this exhibit.

The firm is represented by Rudolf Link, the same as last year, who takes great pains to explain his intruments, and have them thoroughly appreciated. All of the above instruments are of fine appearance and show good workmanship.

The exhibit of George M. Eddy & Co., of Brooklyn, N. Y., consists of metallic and steel tapes. Their steel tapes are graduated in accordance with the standard of the U. S. coast survey, and are corrected at 62° temperature with twelve pounds strain, their variation being 0.08 of an inch for each 10° on 100 feet. F. A. Bone, of Warren county, O., has on exhibition a plat of one township for a county map showing a reduction by photo engraving, which process is attracting much attention.

Topographical maps of position of the grounds of the Ohio State university were shown as the work of the students, which were excellent in every detail. Blank specifications of the Dayton and Columbus sewerage systems, with other specifications of bridge work, stone work and bridge approaches are of interest to the society, and if exhibits of this character were made from every city and county in the state, it would bring about a great reform in such papers and probably be the result of fixing a standard for uniform blank specifications (except in certain details) throughout the state, and by so doing save expense to the counties and much labor to the engineer.

The exhibit by E. D. Wileman of the class of work done by the government C. E. of Australia in their railroad work is the most elaborate of the kind ever placed before the socicy, and in fact nothing but a government would ever require as much time and labor, put upon the plats, profiles and surveys, owing to their cost. Our corporations look more to the progress of the work in hand than to the fine exhibits of maps of their lines.

The blue prints of the bridge work on the Scioto Valley railroad and the

blue prints from photographs are very instructive, as exhibited by the secretary of the society.

Last, but not least, is a 100 foot tape made by Mr. Varney, by Chesterman, one-fourth of an inch wide and much thicker than the usual pattern. Sold by the William Bingham Co., of Cleveland, O.

Respectfully submitted,

F. M. DAVISSON,
Chairman.

Methods and Results of Railway Surveying in South Australia.

BY E. D. WILEMAN.

As a preliminary to the complete understanding of the following notes, you must understand that the railways in the Australian colonies are, with hardly any exception, built and managed by the various colonial governments and that the information embodied herein is based on a four years' experience during 1877 to 1881. Usually as a preliminary to any work on a line the people resident in the district where the line is desired get their member in parliament to propose a trial survey for a line of railway from——to ——, naming the proposed termini of the line, and the usual result is an order to the commissioner of public works to have said survey made and report to parliament thereon, and through the engineer in chief a surveyor is sent out with a party to make the survey. A very usual size for a party is surveyor in charge, assistant surveyor, one or two cadets, according to circumstances, a cook, teamster, and as many men as the nature of the country demands as to whether it is clear or wooded, usually four or five men, who are designated on the pay roll as axemen.

In a trial survey the object is to learn the possible grades and alignment and the character of the country passed through as to ownership, occupation, improvements and topography with, of course, as little expense as is consistent with thorough reliability of the information sent in. I will here insert the instructions given to surveyors by the department:

SOUTH AUSTRALIAN RAILWAYS.

DEPARTMENT OF THE ENGINEER IN CHIEF.

Instructions and Regulations to be Observed in Conducting the Survey of the Railways, by the Officers in Charge of the Survey Parties.

1. The officer in charge of each party will be held responsible for the safe custody and care of the camp equipments, stores and instruments, and will have entire control of the party under his charge.

2. He will be held responsible for the accuracy of the survey and levels taken over the portion of the country allotted to him, and is required in every instance to check the levels of his assistant.

3. Every tangential line must have its magnetic bearing taken at both ends, and the variation from true North must be ascertained by observation at each camp, and entered in the survey book at the commencement of every line.

4. Whenever practicable, the survey should be connected with any established trigonometrical point previously made by the survey department.

5. Good, substantial bench marks must be made at every half mile, and their position noted in the field and level books and recorded on the section.

6. All creeks or rivers which may be intersected must be surveyed for a distance of at least ten chains on each side of the line, and such longitudinal and cross sections taken as may be necessary. In every case the highest flood level of all creeks and rivers must be ascertained, levelled, noted in the field books, and plotted on the sections, with such further particulars with regard to the regime of the stream as may be obtainable.

7. All existing fences within a distance of twenty chains, and building within five chains on either side of the center line, must be surveyed and laid down on the plat.

8. It will be the duty of the officer in charge to see that the levels taken each day are reduced before the work of the following day is commenced. The survey and levels are also to be kept, as far as practicable, plotted up to date, upon the paper supplied by the department, all reduced levels to be written in ink and not in pencil.

9. The plan and section will be plotted on sheets containing one mile each the plan being placed above the section where practicable. The plan is to be plotted to a scale of four chains to the inch, and the section to a scale of four chains to the inch horizontal and forty feet vertical.

10. The officer in charge will in all cases lay down the gradients on the section before shifting his camp, in order to ascertain if he has secured the best line. No gradient must be less than 1 in 60, and no curve must be less than five (5) chains radius, unless under special instructions. Where the ground is sidelong, a cross section must be taken at every chain.

11. The field and level books must be forwarded to the head office in Adelaide as soon as the work plotted amounts to five miles. The officer in charge must also report every fortnight to the engineer in chief upon the progress made, and the character of the country passed through.

12. The officer in charge will be held responsible for a correct record being kept daily in a diary of the work performed by himself and his assistant, which diary shall be at any time open to the inspection of the engineer in chief.

13. Field parties are expected to work on an average ten hours per diem, to enable the survey to be completed within the time specified.

14. The chains and instruments must be tested daily before leaving

camp, and the officer in charge is held responsible for the due observance of this regulation.

15. The officer in charge of each party will be required to see that the horses and express wagons forming portion of the camp equipment are used only for the purposes immediately connected with the object for which they are provided.

16. All curves must be ranged by means of tangential angles, and no other mode of setting them out will be allowed.

17. The crown tangent is to be marked by a post at least six inches in diameter, cut off square at top and sunk two feet into the ground, the exact point of intersection being indicated by a half inch square auger hole, and two saw kerfs crossing each other at right angles, four pegs to be driven around the post at a distance of about three feet from the same, thus ; the commencement and termination of curves to be marked by three pegs, thus: \|/ Where stones can be obtained, cairns are to built up over these points as a protection against disturbance from traffic.

H. C. Mais, Engineer in Chief.

Engineer in Chief's Office, Adelaide, 28th August, 1876.

As to the first clause of these instructions, all survey parties camped, as the country was too sparsely separated to attempt to find accommodation for even the smallest party, among the farmers: the surveyor in charge had a 12x14 wall tent and the others had bell tents. All the tents had floor cloths, linings and flys.

In rapid trial work stakes were only driven at every five chains, those at every ten chains being large, to readily distinguish them. Just here I should like to explain that the Gunter's chain of 66 feet was used for two reasons: it agreed with the work done by the surveyor general's department or land office, and it is even chains to the mile, all distances or chainage being recorded in miles, chains and links. In actual practice, too, they used the great, heavy iron chain with round rings, it being necessary to remove one or more rings every few days to correct the length or take out the stretch. The transit man avoided the use of a back flagman by driving a stake under the transit as tall as possible, splitting the top and putting in a piece of paper, to make it easily found. As soon as the front flag was properly set, the chainmen started out, the rear chainman carefully preserving the alignment, and as soon as the necessary transit notes were taken, the transit was carried ahead by the axeman, who always stays with the instrument, and that leaves the transit man free to take any topography notes needed that can be sketched in from observation, and by the time he has reached the front flag the chainmen are there and his axeman has set up the instrument and leveled it, or nearly so, and so on to the end. Usually in this trial work the curves are not run in unless they would be very long or

sharp. In taking the levels the intermediate distances between the five chain pegs are placed in by the rodman. The rod used is the telescopic self-reading rod, usually fourteen feet long, sometimes as much as seventeen. No target being used, the levelman alone keeps the notes, and a less expensive man can be used for rodman. As far as at all convenient the tallies or even tens are used as turning points, so as to facilitate the work of check leveling.

The rule as to bench marks at every half mile is very rigid, and if no natural object is near at those points a post is planted for the purpose. The secondary surveys of streams, fences and buildings are usually made with the prismatic compass and chain, starting and closing on convenient points of the main traverse, and I would like to impress on every one the value of the prismatic compass on such secondary work.

Clause 14, regarding the testing of instruments, was very emphatic as to chain and level, one of the first duties on pitching camp being to put down a standard for chain, using a steel tape if on hand, or the level rod, if the tape could not be had. The level is always adjusted and tested by means of two pegs, having the same height or a known difference. As a final move on the field work, all possible information is gained as to ownership, occupation and improvements of the property passed through. When the results of the field work are sent into the office the profile is plotted, the plan is made by procuring from the surveyor general's office the lithograph sheets of all the hundreds necessary to make a map of the district passed through, and then the route is plotted on it with a heavy, distinct line; these lithograph sheets are on a scale of 80 chains to one inch, and a book of reference is made up showing the county, hundred, section, owner, occupier, character, as to whether town lots, suburban allotments, farm or stock run, and finally as to whether it is fenced or unfenced (almost all the fences are posts and plain wire). Whatever information is needed in making this book of reference which the field party failed to secure, is gotten by examination of the records in the land title's office, that, of course, applies only to the facts of owner and occupier.

These three items now of section, plan and book of reference form the report of the commissioner of public works to parliament, the section and plan having the title of parliamentary section or plan of the ——— railway, and these are the basis of legislative action on the merits of the project, determining whether it shall die a natural death or pass on to the next stage, known as the contract or permanent survey; in this work the rules and regulations cited above are all quite imperative, and the following supplementary ones were issued:

1. On permanent survey, surveyors' books must give all information necessary as to position and size of side ditches, so that they may be laid down on the contract plan.

2. The height of banks on lands liable to floods must be stated.

3. Where the highest flood levels cannot be determined, the question

of waterways and flood openings must be carefully and thoroughly examined, and the size, headway and position of flood-openings, estimated as being necessary, must be stated.

4. Trial pits and borings must be sunk in all cuttings, and at the sites of all bridges and large culverts, to determine the nature of the ground, so that the slopes of cuttings and works for foundations may be decided on in the office.

5. All possible information must be given as to the localities and distances, at which suitable stone, sand, lime, timber, ballast and other materials can be obtained, and the facilities or otherwise of transport.

6. The country must be thoroughly examined to determine where water for locomotive purposes can be obtained. And wherever it may be necessary to store surface water, trial pits or borings must be sunk to discover, if possible, good holding ground convenient to a large area of collecting ground, and the quantity of water estimated as necessary to be stored at each place must be stated.

7. In laying out the line, regard must be had to the most convenient places for stations, both for traffic and the facilities for obtaining water; the pieces of line, as straight and level as possible must be made for the station yard, not less than twenty chains long, and graded not worse than 1 in 330 cross sections at every chain, and for five chains on each side of the centre line should be taken throughout the station yard.

8. The instructions as to indexing field and level books, which are given on the inside of the covers, must be strictly adhered to.

H. C. Mais, Engineer in Chief.
Adelaide, 13th March, 1877.

And right here I will insert the instructions on the inside of note book covers, mentioned in the last clause above.

SOUTH AUSTRALIA.

{English Coat of Arms}

ENGINEER-IN-CHIEF'S OFFICE.

Level Book No. —

All entries in this Book to be made in Ink, and not in Pencil. The levels taken each day to be reduced at night, and not allowed to accumlate without reduction. Bench marks to be established at intervals of half a mile. After every B. M., the reduced check level to be inserted.

This book is to be kept solely for the purpose for which it is issued, and not for any entry of an irrelevant nature; and to be returned to the Engineer in Chief's office. The contents of this Book must be indexed in a complete manner on the Front Page, and if the Work is continued through Two or more Books, the Numbers of the Preceding and Succeeding Books must be given; also the Number of the Book must be given which contains the Field Notes of.

the Work in this Book The Book must not be soiled, defaced or have leaves torn out nor be detained unnecessarily after the work is finished.

If this Book is used for rough Trial Surveys, or any similar Work which the Surveyor does not require to send into the Office notification is to be sent to the Office that it has been expended in the Work. In all cases the Book must be accounted for.

Issued. ....day of...... ..18

Returned........day of........18

H. C. MAIS, Engineer in Chief.

The same as the above is used in the field book, with the exception of that portion of the first paragraph relating to the reduction of the levels In the permanent survey the centre line is indicated by a line of sawn stake 2″x 3″ and of whatever length the ground (hard or soft) required. One of these was set at every chain or 66 feet, its 2″ dimension being with the line, the great width being to allow room for stamping its mileage or distance on its top with steel dies, thus $^{\text{M}}_{9}$ $^{\text{C}}_{13}$ $^{\text{L}}_{17}$ the face of the stake toward zero, or the beginning of the line being the exact point of measurement, except when a hub was used, then, of course, the tack is the point. The ground is very thoroughly cleared before the final chaining is done for setting these stakes, a strip about one foot wide being denuded of everything in the way of vegetation, and the very last thing the pegs are painted white if the soil is black, or black if the surface is white sand. In pegging out a centre line the direction is first decided upon, run through by hubs, and the intersections at the curves marked by these posts as per clause 17 of the instructions, the angle of intersection measured, the elements of the curve calculated, the external secant set out, the tangents measured off and driven, and then if both ends of the curve can be seen from the centre point of it as located by the external secant the instrument is set upon this center point and the whole curve run in by tangential angles. Then we go back to the previous curve and run in the pegs on the tangent, the chain pins being lined in by the instrument and left by the chainmen for the stake driver who follows to set his stakes by The office work of a contract survey is quite as complete and comprehensive as the field work There are prepared from the notes and plans sent in from the field the contract plan, drawn on long rolls of mounted paper, the longitudinal section, also drawn on roll mounted paper, no profile paper being used there and all the necessary cross sections and special drawings of bridges, etc , that may be required. From the longitudinal and cross sections by the use of bidders' tables the quantities of earthwork are tabulated.

A general plan is also made from the land lithographs, similar to the parliamentary plan, and all these drawings are lithographed. There are then made up three books as a basis for letting the contract First, is a bound book of the lithographs of the general plan and the longitudinal section, a second book of the standard and special drawings, i e , cross sections, fencing, public and private crossings, gates and slip panels, permanent way,

culverts—both masonry and concrete, flood openings and bridges; the book is what would be called here an excessively complete specificati legal cap size and over sixty pages, and comprises specifications, cond of contract, form of tender, conditions of tendering, schedule of qua and prices, acceptance of tender and contract.

The contractor takes a whole line complete, cannot sub-let, has to a deposit of five per cent. of the contract price, and must maintain tl for a period of one year after it is turned over to the government and o for traffic. The contractor also has to hire his own engineer to lay o work, and on large contracts he sometimes gets more pay than the eng in-chief of the colony. The resident engineer of the government has t monthly measurements of quantities, and send in his monthly estima check the laying out of the contractor's force wherever he sees fit; and here I wish to note a great convenience, and that is, tapes and leve divided into yards and decimals for use in measuring the work. In the i of earth work, all cutting or filling of less depth than one foot is called s forming, and paid for by linear measurement alone, which I think is cer the most convenient and just way. The payment for earthwork is upon excavation. Before opening up the work of construction, a most plete system of reference points and secondary bench marks is set (that both alignment and levels can be picked up most anywhere in the convenient manner possible. And finally, it is an unwritten rule of tl vice that every one shall keep his notes in such a shape that any on nected with the service can pick up and carry on his work at a mor notice.

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The Louisville Southern Railroad and Its Branches, With Notes on Construction.

BY S. F. ROCK.

Three years ago, at the suggestion of our President, we wrote an article to be read before you, on the "Location of Railroads"—a subject worn threadbare, but still one in the execution of which perfection in skill and in the application of theories has never been reached. A location has rarely been made, and supplemented by construction, in which some changes have not been found desirable and economical.

As the writer has been, since July, 1887, continuously engaged in the engineering department of the Louisville Southern Railroad and its branches, it is thought that perhaps a brief resume of this work might be of interest to some of our members: The Louisville Southern Railroad is the outgrowth of an idea entertained by citizens of Louisville that the Louisville & Nashville Railway systematically treated Louisville trade, at all points in the South not common with this road and the Cincinnati Southern Railroad, with a carelessness and neglect that in many instances proved a source of loss to her merchants, and hindered the proper expansion of their business with the South, to which section they naturally look for the larger portion of their trade.

As first projected, the Louisville Southern Railroad was built from Louisville, via Shelbyville, Lawrenceburg and Harrodsburg, to a junction with the Cincinnati Southern at Burgin, eighty-eight miles southeast from Louisville. This at once gave them competition, by practically giving to Louisville the Cincinnati Southern as a further outlet. The management of this enterprise next took a short line of road that had been built from Versailles to Midway, and extended this to a connection with the Cincinnati Southern at Georgetown. Next followed the construction of a branch from Lawrenceburg, via Versailles, to Lexington, forming a junction at Versailles with the line previously extended to Georgetown.

Their ambition next prompted them to undertake the construction of another branch line from Versailles, running eastward ninety-six miles to Beattyville, at the Three Forks of the Kentucky river, and in the coal fields of Eastern Kentucky. This is nominally a new company, called the Richmond, Nicholasville, Irvine & Beattyville Railroad; and as located through the heavy-rolling, but beauteous blue grass counties of Woodford, Jessamine and Madison, and a portion of Estill, is what is sometimes called a "cross country" route, while from Irvine, the county seat of Estill, it follows the valley of the Kentucky river to Beattyville. Besides the towns of Versailles

Irvine and Beattyville, there are on this line the thriving points, Nicholasville and Richmond, the former in Jessamine and the latter in Madison county. Versailles, Nicholasville and Richmond, as may be judged from their locations, present advantages that could not fail to suit the most fastidious seeker for a home. Their educational facilities are of the best, and in social advantages they are unequalled; but, "tell it not in Gath," these people know all this, and rate their real estate accordingly.

Irvine is located on the Kentucky river, and is a place of some note, being the location of the famous "Estill Springs Hotel," which, during the summer season, is often thronged with health and pleasure seekers from all parts of the United States. It is also on the borders of the mountains of Eastern Kentucky, which here rear their crests and stand as mighty sentinels for the "serried hosts" beyond, forbidding by their aspect the further progress of improvement, and hiding in their fastnesses (who can tell?) how many dark and bloody histories.

These mountains, as I write, are covered with the many and changing hues with which autumn decks her forest leaves, and present to the eye of Nature's student innumerable grand vistas, fading with distance into a bluish haze; scenes alike entrancing to the mind and ennobling to the soul, as through the contemplation of these works of a Supreme Architect, we are led to consider not alone the beauties of nature, but our duty to Him, the Maker and Finisher of all things. Nor is the charm thus thrown around you by Nature dispelled until, perhaps, the flounderings of your faithful horse, knee deep in the shiny mud on some of the mountain or valley roads, which have been rendered almost impassable by teams in drawing the many and ponderous loads of material needed on construction, calls forth mental, if not at times oral anathemas on mountains generally, and these Kentucky mountains in particular.

In constructing these lines it has been found necessary to cross the Kentucky river at three points, and to also construct some very high viaducts. The first crossing of the river is on the Lexington branch near Tyrone; the second is at the mouth of Tates creek, nine miles east from Nicholasville, near Valley View station, on the R. N. I & B. railroad, and the third at Irvine, on the same line. The most noted viaducts are at Neal's branch and Marble creek, about seven miles east from Nicholasville.

The bridge at Tyrone is a steel cantilever, which, at the time of completion, was said to be the highest and longest in America. This structure is supplemented at each end by viaduct work. Its extreme height is about 258 feet; the total length 1,598 feet. The distance from centre to centre of anchor towers at the ends of the shore arms of the cantilever is 998 feet, and from the centre to centre of main towers 551 feet. The main towers are each supported by four cylinders, which are sunk to bed rock below the bottom of the river, and were each filled with concrete. A full description of this structure, with numerous views, strain sheets, etc., can be seen in the Engineering News of the date, April 5th, 1890, and so well has the subject been

handled that it is useless to here say more than that in its bold conception and the unparalleled rapidity of its erection, great credit is due, not only to the chief engineer of the railway company, Col. John MacLeod, but also to the Union Bridge Company, of New York, and the willing and able men sent out by them to superintend the work.

The second crossing is of a different style, it being only 111 feet from the base of rail to the bed of the stream. It was decided to adopt for the channel span a "through truss," 300 feet in length, supported on cylinders. The west approach is composed of two deck spans, 150 feet each, and 480 feet of viaduct, while the east approach has one deck span of 150 feet, and 330 feet of viaduct, a total length of 1,560 feet. The entire bridge is of steel, and the spans are of the style known as "Thatcher truss." Owing to the scarcity of good building stone, cylinder piers were used as supports for these spans, and were filled with rubble masonry laid in cement mortar. This masonry was of large, well-shaped stone, and the mortar used was composed of one part "tested" Louisville cement and two parts sand. The alignment over this bridge is not good, nor could it have been made better without an entire change of route in approaching the river, and an enhanced cost that would have stopped the enterprise.

The west approach to the middle of the first 150-foot span is on a 6° 30′ curve to the right, and the viaduct work on the east approach is on a 5° curve to the left. Great pains were taken, however, to secure a proper elevation on the curves and approaches, and the whole forms a beautiful and substantial but unique structure. It was built by the Shiffler Bridge Company, of Pittsburg, Pa., from designs furnished by E. S. Thatcher, of Louisville. Mr. Thatcher and Mr. J. H. Pearson, chief engineer, also designed all other plans for bridges and viaducts on the R. N. I. & B. railroad.

At the third crossing, a fine quality of free stone being found conveniently near, abutments and piers were constructed. Here the height from bed of stream to base of rail is 91 feet, and the total length 1,280 feet. The west approach is composed of three deck spans of 100 feet each, the channel span is a "through truss," 270 feet long, and the east approach has five deck spans of 100 feet each, and 210 feet of viaduct work. This structure is to be on a tangent from west abutment to pier No. 8, and from this point to the east end on a 6° 30′ curve to the right. The masonry will be completed during the month of January, 1891, and the bridge shipped in and placed in position during April and May following. The bridge is under contract with the Pencoyd Bridge Company, of Philadelphia, Pa. Neals branch and Marble creek viaducts are noted for their height, being respectively 185 and 211 feet above the beds of streams. They are each across narrow, deep canons, through which these tributaries of the Kentucky river have outlet.

Lattimer guards will be used on all bridges, viaducts and trestles. Wooden trestles of the standard type used in Kentucky and Indiana have

been used where needed. Where suitable stone was to be had, stone c verts have been built. At other places large size drain pipes, wooden b culverts and small trestle openings were substituted.

The road bed through cuts has a uniform width of 16 feet; rock cu slope ¼ to one; earth 1 to 1, except where liable to slide, and in such cases was aimed to take out enough to insure stability. The maximum grad (used only in one instance) is 90 feet per mile, and the maximum curve 10 (not used).

Four tunnels were found necessary, three being through rock, and one through a shaly limestone, which required timbering. Our tunnels were all driven with a top heading. Two are on six degree curves, and one on a six degree and thirty minute curve, and one on a nine degree.

By reason of the errors so likely to occur in numerous deflections, and to prevent the inaccuracies usual in deflecting for short chords, our resident engineers were furnished with carefully calculated distances on tangents, corresponding to each five feet as measured on a 100 foot chord, together with the distance from these points to the centre line of tunnel (not track). These calculations were made for 100 foot chords on 6° curves, and after this distance from the portals had been reached, an angle of 12° was turned, which allowed a repetition of the process for a further distance corresponding to true 100 feet chords. We have found that this method combines the least amount of labor and the greatest possible accuracy, both of which are desirable in this class of work.

Preparatory to this, our alignment was securely fixed and the sub-tangents carefully measured and re-measured with level boards and plumb lines. Much use was also made of the level board in establishing the centre line and reference points for our viaducts. All points on curves and tangents were securely referenced as the work progressed. Vertical curves were used at all changes of grade. Steel ribbon tapes were used in preference to the 100 foot link chain. They are marked at each foot by a drop of hard solder, upon which is stamped the foot mark and number. Our men soon became expert in doing these up in a portable shape, and do not care for nor use a rule.

The engineering department on the R. N. I. & B. railroad consists of a chief engineer for the railroad company, a chief engineer for the contract company, and on each eight miles of the line a resident engineer, assistant rodman and axeman. The engineer for the contract company has immediate charge of all the work on the line, and carefully supervises the work of each residency, making personal visits on every possible occasion. He classifies the work and, in short, gives attention to any and every subject that arises. All estimates are prepared by him from monthly reports made by the resident engineers. He makes reports to the chief engineer of the railroad company, to whom he ranks as principal assistant or division engineer.

Inspectors of masonry, trestles, pile bridges, etc., report directly to res-

ident engineers and make special reports to the division engineer when called for. All plans and bills of material are prepared and sent out from the general office. Plans furnished are blue print copies, and bills of material are all type written, and each must be authenticated by the approval of the chief engineer of the railroad company. This officer, besides taking a general supervision of all portions of the work, also acts as a purchasing agent in procuring track materials, rolling stock, etc. He also examines into and reports upon all estimates and other matter furnished by the division engineer.

Railroad work in Kentucky is usually let as a whole to the contract company organized for the purpose, and is by them sub-let to other parties who, in turn, sub-let to others, usually to the deep sorrow of the last man and of the community where his work is located. This contractor has none but himself to blame for losing money, but it is extremely common to hear of him trying to make himself whole, by either cajoling or intimidating the resident engineer.

What Knowledge Shall be Required of a Man to Practice Surveying or Engineering?

BY PROF. C. N. BROWN.

I suspect that some of our members who have been associated with the Society since its beginning will elevate the eyebrow and shrug the shoulder and ask why this old question is again dragged up. Why can't it be let alone? This idea of having some qualification for surveyors was one of the important objects of the formation and of the first few years of the life of this Society. At least I gain that idea from the early reports. It was discussed over and over again; bills were written and presented to the legislature, and considerable work done toward having them enacted into laws. But in the meeting in January, 1885, the idea of ever having any satisfactory laws passed was given up in disgust, and it was concluded to take out papers of incorporation and to devote all energy to the elevation of standards of work through a society of surveyors and civil engineers.

From '85 on, nothing, I believe, has been done toward securing legislation in regard to surveyors and engineers. The subject comes up in discussion nearly every meeting, being brought up usually by new members who do not know of the past efforts. The society has endeavored, and with success, I think, to have papers and discussions on subjects of importance to all surveyors and engineers. It has, too, I think, materially benefitted those who attend the meetings or read the reports, by inciting them to better work and to study so as to make themselves better able to do good work. Perhaps the body of the papers has been better adapted to engineers than surveyors simply, but every year there is considerable discussion of subjects of vital interest to surveyors.

The question of legislative action in regard to qualification for surveyors is like Banquo's ghost and will not "down," and in view of this fact it is a question in my mind whether we ought to drop it, or whether it would not be better for us to pick our flints and at it again.

The State requires persons who wish to practice law, medicine or pharmacy to know certain things about those subjects, or require that the practitioners have certain qualifications. The U. S. government requires that a man must pass certain examinations before he can be captain, mate, pilot, or engineer on a steamboat, no matter how small or unimportant. Surveyors and engineering societies of other States have had about the same experience as this society. In looking through the society reports that come to us by exchange, I find that Indiana, Illinois, Iowa, Missouri, Arkansas and Michigan have made efforts to have laws passed requiring certain qualifica-

tions in surveyors In all of these States I find the societies becoming discouraged, and as far as I can judge from their reports abandoning the matter It may be that some States have such laws, but I know of none In all cases the opposition to the law was hard to locate, in some cases impossible Usually it was killed by professional politicians and surveyors who would have nothing to do with the society, evidently usually by men who feared an investigation of their abilities by men who were satisfied to go along as they had all their lives who had no ideas of progression or growth in their profession, who had an idea that they knew all there was to know about the matter, and who expect to leave the world bankrupt in the knowledge of surveying when they die, in a word, by men who are old fogies.

Of course, in some cases surveyors and engineers came out openly and opposed it for reasons that they gave and which, to them, seemed conclusive. There are, of course, two sides to the question, and a few good points can be stated against the idea, but I think many more can be given in favor of it.

When I promised Mr Griggs to give my ideas on this subject, I hoped to have time to find out how the matter stood in other countries, but I am sorry to say I have not been able to carry out my idea—I hope to at some future time, if I am not completely squelched this time But from our exchanges I find that in Canada a man must be examined in the following subjects at least before receiving permission to practice surveying Six books of Euclid plane trigonometry, mensuration, fractions, plotting and map drawing, enough spherical trigonometry and astronomy to find the latitude and a meridian, square and cube root, and logarithms.

In our fourth report, '83, is a letter from a gentleman who has practiced in Australia. He says that there surveyors must pass an examination and have two years' field and one year's office practice before receiving a license to practice

Last summer I became acquainted with a young Swede who had worked on railroads at bridge construction in Sweden. He said that none but graduates of a certain State technical school were allowed to practice as engineers and surveyors It might be well to say that the railroads are operated by the government, which would, of course, change the phase of the matter somewhat

Now, inasmuch as several State societies of surveyors and civil engineers have made efforts to have State regulation in the matter, and have thought it for the best good of both surveyors and people, and, as other countries think it best to require some knowledge of the subject, it seems to me that there must be something good in the matter, even if there were no other reasons

The following circumstance was one of the first things to impress the matter upon my mind It occurred a number of years ago, I think, when I was a student at the O S. U., and I have entirely forgotten the man's name and the county he hailed from A man came from a county in the western half

of this State to the State university to study surveying. He stated that he had been nominated for county surveyor and that a nomination by his party (I don't know which it was) was equivalent to election in his county. He had had a common school education, and seemed an honest sort of a man. He wished to prepare himself for the duties of the office he was soon to fill, and wanted some instruction in surveying. Well, he took private lessons in Loomis' surveying for about one month, and then left. I have never heard more of him. I don't know whether he was elected or not. I hope not. One can imagine how well fitted he was to fill the office.

Another case: I knew a young man who went from the farm to a certain school for two terms—about six months. He had been going to a very ordinary country school—had never studied algebra, geometry or trigonometry before going to college. When he returned he gave out that he was a full-fledged C. E. I had some acquaintance with him, and on one occasion pumped him a little as so what he had studied. He had skimmed over algebra into quadratics; had a smattering of geometry and plane trigonometry; had learned how to read a compass and how to calculate areas by latitude and departure fairly well, and had studied some parts of Trautwine's Pocket Book. But his knowledge was hardly skin deep, and I fear he honestly believed that he was a competent C. E. He had been told so by his teachers and was not entirely to blame. He was nominated by one of the parties for the office of county surveyor, and made a vigorous effort for election, but, fortunately for the county, he did not make the race. If elected he would probably have had charge of road building, wooden and iron bridge work, and pier and abutment masonry. How would the work been cared for?

At this writing I know of two cases in this State of young men trying for the position of city engineer of cities of 10,000 to 20,000 inhabitants. The towns are nearly 200 miles apart and not in any way connected. One young man has gone to school and studied surveying and mathematics three or four terms, but has never had any experience worth the mention. He has never studied anything relating to street or sewer construction. Is a nice young man and will probably get the place. I do not know what kind of a man he will replace. I expect if my friend gets the place that he will study and try to fit himself for his work.

In the other case, the young man has a grammar school education; has probably studied surveying a little under a surveyor that he has worked for; has had some practice in land surveying, and is simply utterly incapable of carrying on the work that the city does every year. Yet he has very nearly succeeded in displacing an experienced and able man, and probably will not many years in the future.

The simple fact that these things or worse can be true is, I think, enough to urge us to bring about a change. I do not doubt all of you can call to mind cases where men entirely unfit have been elected county surveyors or given charge of important works by county commissionors or city councils. I know that cases of this kind are not the rule, and I know that there

are many, very many, capable and honest surveyors and engineers in our State. But still the fact remains that there is nothing to prevent a man holding the office of county surveyor who does not know a compass from a Gunter's chain, or a man being chosen city engineer who would not know a transit from a level, or ever heard of sewerage.

Now as to the solution of the problem: It may be that we all recognize the deplorable state of affairs, but some one will ask, "Well, what are you going to do about it?" That is the question What are we going to do about it? It is always easy to find fault and to tear down, but to prescribe the remedy and apply it requires wisdom, perseverance and courage. I do not think it probable that any one man can give us the entire plan or that the first plan will work perfect satisfaction But if we go at it in the right spirit and discuss freely the plans that are proposed, I do believe that we can bring about a change for the better. I think that it can be brought about without our being charged with a scheme to increase our fees or salary. I think that that item should be left in the background and that it will arrange itself, and for the better, too.

Those of us that think that there should be requirements will have plans to propose, and those who object to the scheme will tell us how they will fail to work, or how they will work injustice, or how they will open the way to corrupt and dishonest practice. Taking it all in all, I think that this society can submit, if it so wishes, to the legislature a bill that will greatly improve matters. My plan has not been matured as well as it ought to be, but I will give the main points as I think they ought to be They will be a basis for discussion

First. I think that a distinction ought to be made between surveyors and engineers. I think that a man who has charge of the designing and construction of ditches, roads, bridges, masonry, city street pavements, city water works, city sewers, etc., etc., should have more knowledge and more and different experience than a man who expects to only survey lands, or do surveying on roads, etc., under an engineer.

Second. I am undecided whether or not it would be well to include or exclude railroad engineers In some ways I would think it right, and in others wrong. Railroad companies usually look well to their own interests, and do not, as a rule, employ any but those who are competent to do the work required of them. If an incompetent man does secure a place he does not hold it long.

As to all the subjects in which examinations should be required, I am also somewhat at sea. I think among those required the following should be found Algebra, geometry, plane trigonometry, mensuration, land and railroad surveying, lettering and plotting, methods of dividing land in Ohio, Ohio laws concerning surveyors and surveying. The candidate should have had at least one year's, if not two, practice as chainman, etc., under a licensed surveyor.

As for the grade of engineer, I think the requirements ought to be very much more complete. Our county engineers have to build roads, put culverts under them, bridge the streams, put in the bridge masonry, etc., design drainage ditches, etc. The city engineer builds streets and sidewalks, designs systems of sewers and constructs them, also frequently water works, a variety of masonry work, bridge work, etc., etc. It seems to me that men in such positions should be compelled to show the public in some way that they have at some time made a study of these subjects.

I understand that any one man, in these days, cannot be an expert bridge engineer, an expert sanitary engineer, and an expert water supply engineer. Each field is large enough for a life work. But one man can be acquainted with the fundamental principles underlying all these, and can know enough to know that he is not an expert in all these branches. He would be able to carry out intelligently the plans of an expert in any one line, and could deal with the simpler cases of any one or all of them.

Take the matter of highway bridges: Our counties and cities build many of them each year. The county or city engineer is called on to furnish data and specifications for the structure. The engineer, or perhaps the county commissioners or city council determine the span and the roadway; the engineer sometimes specifies the live load and factor of safety only, allowing the bridge company to furnish their own specifications; or the engineer may specify some standard specifications as Cooper's or others. Ten, fifteen or twenty bridge company agents appear on the day of letting and put in bids. The bids are turned over to the engineer usually, to say which is the best bid for the price, or it may be the lowest bidder is awarded the contract at once. When the bridge is finished the engineer is usually called on to say whether or not the bridge is built according to the specifications. The engineer may run through the strain sheet, may, perhaps, figure the members of the truss, but how many pay any attention to the details, the rivets, pins, sway, bracing, etc., etc.? How many measure up the $\llcorner$s | and the $\llcorner$s to see if they are of the size shown on the strain sheet? How many could do all these things? Theo. Cooper says that a 14-year-old boy ought to figure the strains in a truss, but it requires many years of study and experience to design the members and details of a truss. I have my doubts about the 14-year-old boy doing much with the matter, however.

A bridge man once told me that he knew of one county engineer in Ohio who specified 200 pounds L. L. per square foot of floor for county highway bridges, and that the bridges built in the county would not average over 60 or 70 pounds per square foot, and that the engineer thought he was getting a 200-pound bridge. I hope the bridge man lied, but there is nothing to prevent such a state of affairs existing.

As I said before, I am not clear in my own mind as to what subjects nor how thoroughly a man ought to be examined in order to be allowed to practice engineering. That is a minor point, just now, and could be left with

the examiners probably. I think that he should have had some experience as a surveyor under an engineer, say one or two years.

The question will be asked, "How is a man to acquire all this knowledge? Must he go to college?" It may be said that this is written by a college man and is simply a scheme to fill his classes. As to this last point, I will say that my classes are of a very comfortable size now, and if they grow very much, additional help will be required to handle them.

I think that it would be well for a young man expecting to follow surveying or engineering to go to some engineering school and complete the course, if he can; if he cannot do that, take as long a special course as he can. There are quite a number of good engineering schools in the country. As for Ohio, we think, of course, that we have one of the best at the Ohio State university, but there are other good schools not far away that could be easily reached, as Ann Arbor, Terre Haute, Champaign, Cornell, Lehigh, Institute of Technology at Boston, and others. I would advise a young man to make every effort to go to some good engineering school if he expects to follow surveying or engineering. I know that he would require some practical experience before making a good man in his profession, nor do I claim that *all* persons who would follow out this course would make first-class engineers. It is necessary that the young man have an average quantity of that valuable material known as common sense. There is an old notion abroad in the world that all young men who go to college have to fight, and that is, that when a person goes to college or has graduated from a college that he should know everything from Greek literature to the latest discoveries in electricity. Of course, a young man just out of college does not know all that you do about the work that you have practiced for years. Give the boys a chance, and you will see that they can learn, and learn rapidly, too.

Now I have said that I would advise a young man to go to college, but I have not said that it would be necessary for him to do so in order to pass the examination. If a young man has the grit to dig into the work, and if he can get a lift now and then from a friend who has been over the road before him, he can acquire all the necessary knowledge to pass a reasonable examination. It will take him longer and he may not have it quite as well as if he had gone to school for it, but he can get it.

I imagine that some of our members who have been long out of school, or who have never had the advantages of a college training, are thinking that I am getting up a scheme that will either stop them from practicing or put them to great inconvenience and labor in preparing for these examinations. I know that many of our county and city engineers and surveyors have been doing good work for years, who could never at any time in the past pass an examination such as I have intimated. I say this without wishing to be disrespectful or to speak slightingly of them or their work. *All honor to them.* They have shown that they wish to learn, and wish to perfect themselves and to raise the standards of the profession by the formation of this society.

by their interest in the meetings, by coming here and reading papers and taking part in the discussions, when they could be earning money at home.

My plan to accommodate these men is somewhat like this; I have no doubt it could be improved: Let the law that inaugurates this new order of things say that any person who has served as city or county engineer or practiced engineering for a certain number of years—to be yet determined—be given a license at once as engineer; and the same for surveyors—anyone who has served as county surveyor one or two terms, or who can show that he has practiced surveying for a certain number of years, be given his papers as surveyor. And then for anyone who wishes to begin practice in either line of work after the date of the law be required to pass the examinations.

There are many questions as to the advisability of doing away with the office of county surveyor, or the relations between the county surveyor, if not abolished, and licensed surveyors, that I have not studied and will not refer to, except to say that they ought to be carefully studied before anything is done. This change would be a radical one and ought not to be done hastily. The society ought to have a well matured plan to submit to the legislature, if it should think it best to do such a thing. Every point for and against should be well considered, and statements prepared to meet the objections that will be brought against it.

If no other State has such regulations, ought not Ohio set them a good example? If other States do have them, ought not Ohio hasten to place herself on the right side of the question? If anything is done in the matter, this society will have to do it. Is it not time for us to be up and doing?

Since the meeting in January I have collected the following information in regard to the requirements in some of the United States and Canada.

The Revised Statutes of Ontario, 1887, Vol. I, chapter 152, says in substance that:

No person shall act as a surveyor of lands unless duly authorized, under a penalty of $40.

The board of examiners consists of the Commissioner of crown lands, the professor of mineralogy and geology in University college, Toronto, and eight other competent persons appointed by the lieutenant governor. The board meets twice each year to hold examinations. Three members form a quorum.

A young man who wishes to become a surveyor must give the examining board due notice, and pay a fee of $1. He then takes the first examination. If he passes this examination and pays two more fees amounting to $12, he obtains a certificate allowing him to become an "apprentice." This first examination is in penmanship, orthography, fractions (decimal and vulgar), square root, logarithms, algebra through equations of the first degree, geometry (four books of Euclid), plane trigonometry, the rules for spherical trigonometry, mensuration of superficies, the use of the ruling pen, and construction of plain and comparative scales.

The young man must then serve for three successive years under an in-

strument in writing as apprentice to a land surveyor duly admitted and practicing in Ontario. After obtaining a proper certificate that he has so served, and of his character, and if he is 21 years of age, he can take his second examination, after paying certain fees, which admits him to practice as land surveyor.

The second examination includes the following subjects, viz. Geometry (six books of Euclid, except last thirteen propositions in book five), algebra (including progression), plane and spherical trigonometry; mensuration of superficies, laying out and dividing of land, descriptions by metes and bounds for deeds and other instruments; the use and adjustment of surveying and leveling instruments, the laying out of curves, practical astronomy (including the finding of time, latitude, longitude, azimuth, variation of needle and drawing meridian line), the acts relating to the survey of lands in Ontario, the general mining act, the registry act, so far as it relates to plans, the municipal acts, so far as they relate to roads, surveys and drainage, the ditches and water course act, the theory and practice of leveling, the principles of evidence, drawing of affidavits, taking field notes and preparing plans, the rudiments of mineralogy and geology, the sufficiency of his surveying instruments.

He must perform such practical operations in the presence of the board, and shall answer such questions, on oath, with regard to the actual practice in the field, and with regard to his surveying instruments, as the board may require.

If he is successful in the above examination, he must then furnish a $1,000-bond, with two sureties, for the faithful performance of his work. He must also take the oath of allegiance. He must also provide himself with a standard measure of length and have it tested by the board. And then, after certain other fees are paid, he is given a certificate that he is qualified and may survey lands and be known as a "provincial land surveyor."

This certificate may be revoked by the board if the "P. L. S." does not conform to all rules and regulations. Provision is made so that graduates from certain schools may present their diplomas in place of all the three years of apprenticeship.

Below is a list of States and the date of the copy of Revised Statutes examined, that make no requirement of county surveyors: Illinois, 1885; Indiana, 1888; Kansas, 1889; Idaho Ter., 1887; Georgia, 1873; Michigan, 1882 and 1890; Massachusetts, 1882 and 1887; Maryland, 1888; Maine, 1883; Mississippi, 1880; Missouri, 1889; Minnesota, 1878 and 1883; Montana Ter., 1879; New Jersey, 1709-1886; California, 1885; Arkansas, 1884; Ohio, latest. Louisiana, 1884, requires that the Surveyor General shall be able to speak three languages.

Land Surveying.

BY G. S. INNIS.

To be a good land surveyor and one that can accurately survey or measure and mark out the lines and set the corners of a parcel of land correctly, requires a very considerable degree of skill and some experience. Of course, no one ought ever to even begin to do or direct such work unless he has a thorough knowledge of mathematical science from common arithmetic to the highest branches. Mere technical terms and to be able to repeat them parrot-like amount to nothing; but a thorough knowledge of principles and their application is absolutely necessary to well equip the surveyor for his work. The hardest jobs we have to do, and the most unsatisfactory when done, are when we have to follow after an incompetent or careless workman, and, unfortunately, most of our early surveys in Ohio were made by one or the other class of surveyors. There were some apologies for employing such men one hundred years ago, but certainly there are none now. With all our public schools and colleges, there is no reason why the public should be afflicted by having an incompetent workman thrust upon it. One such a man can and often does as much harm in a single day as he earns in a year. He sets neighbors at variance who were living in peace with each other before. Perhaps they go into the courts when, of course, lawyers' fees and other costs accumulate rapidly, until it soon becomes a question of costs and not who owns the little strip of land about which the contention began. After spending many times as much time and money as the strip of land is worth, it all ends where it should have begun, by being referred to some competent surveyor as a special master, to go upon the ground and find the old line and report to the court. This is done, his report confirmed, and peace again reigns in the neighborhood. Another grave error some surveyors make is to depart from an old established corner. Take the best evidence which can be obtained, and find the place where these point out that the old corner was located, and fix it there. In no case depart from an old stone or other monument fixed in a corner and with which all parties at interest have been and are still satisfied. I have known even this to be done and caused not only a neighborhood quarrel, but a long and costly lawsuit over a strip of land worth less than ten dollars.

I think of a case just in point: A student just out of college, well educated in the schools, but without any practice, was called upon to divide an estate between the several heirs; he was all theory, and supposed he could go on the land, establish a base line, turn off the degrees with the vernier on his fine new transit, and thus bring everything to the inch or less. This he might have done had the work been so performed in the original survey.

But at one of the corners he missed an old corner stone (which had been planted more than twenty-one years and was satisfactory to all parties interested) about twelve feet, made a new corner and sub-divided to this line. One of the heirs sold to a stranger, and of course deeded him to this new line. The purchaser, naturally enough, claimed what land he paid for, and a quarrel ensued, they cut each other's fences down, finally came to blows, and then into the courts. After lawing till all parties tired of their differences, it was referred to your humble servant to make the survey and report to the court. Upon going on the ground, it was found that the point in dispute laid some distance south of two well defined and adjoining corners. These two corners were joined by a right line. From these two undisputed monuments the bearings and distances of the original survey were taken. From the bearings the old angle at the disputed point was easily obtained. This gave a triangle in which were given two sides and the included angle to find the other angles and side. This being done, a perpendicular was let fall from the long or closing line toward the two points in dispute; calculating the distance on this perpendicular line and applying the measure thereto, it struck the old corner stone near the middle. This proof was so clear that no mathematician would for a moment dispute it. The court soon decided the old corner to be where the stone had been planted years before, and this decision was correct.

Another knowledge quite necessary is a familiarity with the laws of the United States and this State governing land titles. Without this the surveyor is not well equipped for his business, however much he may know in all other directions. He must know when to pro-rate surplus or shortage between the parties adjoining, and when to give certain parties their metes and bounds, and the remainder more or less to other parties. Frequently some fine questions of law come in here, and should not be too hastily decided.

Another thing the land surveyor needs and cannot well do without is a good supply of common or business sense. Without this quality he will often become excited and incapable of deciding correctly between parties, especially where one party is abusive, perhaps orders him off his land, and the other party is a gentleman in all he says and does. It is very hard sometimes, but then the surveyor must keep cool, that he may do exact justice to all.

Some young surveyors start out with the idea that if anyone is favored it should be their employer, forgetting that the way to favor him best is to give him just what belongs to him, neither more nor less. Do right between man and man for the love of right, and everyone's interest will be best subserved thereby, even your own conscience.

Transit Points.

BY JOHN L. CULLEY, C. E.

The magnetic needle has been used in land surveys for several hundred years; history does not enlighten us of the exact date of its first use for this purpose. The needle was used by the Chinese some 2,600 years B. C. It was a short sensitive needle, about one inch long, suspended below its center of gravity. The art of measuring survey angles by graduated circles is of quite modern date; we are quite surprised, when we look up its history, to find that the first circles were very large, and that with the advance in the mechanical arts the size has been radically reduced, rather than beginning with small circles and then increasing them from time to time. Fabulous stories are told of the instruments used in the latter part of the last and the first part of this century. We are informed of a certain German engineer who used an instrument of seven-foot telescope, etc. Its size has undoubtedly been magnified by the lapse of time since its use. It is true, however, that the old instruments were cumbrous and crude: their weight alone made their transportation slow and tedious; they weighed from five hundred to one thousand pounds, and their manipulation required a small army. During the early part of the eighteenth century, the quadrant was used in land surveys, and on account of its portability undoubtedly must have been used considerably after the first theodolites came into use. The desire for an instrument that would supersede the needle, with its uncertain angle reading, led to many attempts at precision by graduated arcs and circles, hence the use of the quadrant. The survey of Zealand, Denmark, in 1762-8, with an instrument of two foot diameter circle, is said to be the first recorded survey with an entire graduated circle. It was a great triumph when Ramsden, an English instrument maker, finished his great theodolite, in 1787, having a graduated circle of three feet in diameter. This instrument was used in the trigonometrical survey of England and Wales, and was followed by others of similar construction, the circles varying from two to three feet in diameter, and their telescopes from two to three feet long. The German instrument makers soon followed, and excelled their English brethren in their manufacture.

However, early in this century Edward Troughton, in England, brought out the first portable theodolites, with circles of eight to ten inches diameter. These must at that day have appeared quite small, as they would to-day be considered equally large. This invention was a great advance in practical surveying, and opened the way for the universal adoption of telescope instruments in land surveys. It is more than probable that cross wires were first introduced about the middle of the eighteenth century, as the telescope

would, of course, have been useless without them. With their use was the beginning of accurate work. There was, however, a charming facility with which one could look around obstacles through the old compass sights not to be found in the telescope.

The question naturally arises: why did not the old engineers turn off 180° in the prolongation of a straight line, instead of the tedious and uncertain process of reversal of telescope in the Y's? The answer is that all graduation was so poor that it was not to be relied upon.

At the suggestion of the engineers of the Baltimore & Ohio Railroad, Wm. J. Young, of Philadelphia, in 1831 invented the first portable transit. The good judgment of the inventor is evident from the fact that this first instrument had the identical characteristics of the best-made instrument of to-day. With a five-inch needle, nine-inch telescope and vernier inside of the needle ring, reading the limb to three minutes, the two plates moved over one another by a rack and pinion movement around a flat disk center between them. It had a single, round or universal level. This plain, substantial instrument served a great purpose in the early days of internal improvements. Its advantage over the theodolite was its capability of rapid handling, more accurate adjustment of the line of collimation and the determination of points in opposite direction.

The flat center of these instruments led to discussions as to the merits of flat and long center instruments, concerning which we now hear nothing, as all instruments are now long centers, and the fact is universally recognized that instruments of precision are of delicate construction, requiring careful handling.

There has been a wonderful development in all the mechanical arts since the advent of the transit, and it is to its later improvements that we would call attention. The old authorities asserted that the best made engineering instruments had errors, due to mechanical inaccuracies, as great as three minutes; nor is this to be wondered at: the early graduations were made from circles mechanically sub-divided, eighteen inches in diameter; to-day, graduations are made from automatic engines, some as large as forty-eight inches in diameter, and so great is the precision arrived at, that in the Government coast surveys the twenty and twenty-four inch instruments are graduated to every five, or even to every two minutes, and are read to single seconds; and the test of their efficiency is that the coast survey triangles usually close within one second, and often, in fact, says T. C. Mendenhall, superintendent of the coast survey, within one or two tenths of a second.

The lower plate clamp has ever given satisfaction, for when once set it has held fast; not so with the upper plate clamp, so generally used until lately, on account of its slight frictional surfaces and liability to slip on the slightest provocation, you could not hastily remove the instrument from a critical position as, for instance from a track in front of an approaching train, and read with certainty the observed angle. This defect has been

nost effectually remedied by a strap clamp placed directly under the lower plate. This is the one great improvement in the transit. The advantage of this attachment is great where a given angle is to be repeated at each set up of the instrument. The direct acting tangent screw was the cause of much lost motion, due to the wear of the screw thread. The modern tangent screw acts against a strong spring coil, thereby taking up all looseness due to thread wear. No longer are we annoyed by the jerky motion due to lower double opposing tangent screws; a fine, slow, precise motion is now secured for both the upper and lower movements.

Some makers still persist in using the old-fashioned upper clamp; clamps should be strap clamps and tangents single, acting against a strong spring coil.

Adjustable tripod heads are a necessity where telescope tripods are not used; with it there is but very little use for shifting heads. Much prejudice has been exercised against telescope tripods—that they were weak, shaky, etc. Experience has demonstrated the fact that this tripod has no equal in the market; it is fully as strong as the solid leg, is light, portable, readily adjusted to all conditions of surface, and compact when closed. The inherent weakness of all tripods has been the screws in the head regulating the movement of the legs; they need adjusting generally when the appliances for moving them are far away, or when the screws are set beyond redemption. These screws should be plain thumb-screws, which some of our enterprising makers are now supplying. The quick leveling device has met with little favor, and perhaps for the good reason that there is little use for it.

Much time could be saved in quick handling of the transit, if there were some device whereby the o.o's of the limb and vernier could be quickly brought together; often two or three complete revolutions will be given before the desired position is secured. By placing a small rosette, as, for instance, a small screw, on the lower plate directly under and opposite the o.o's of the limb, then the fingers could move around until this index is met, when the plate could at once be brought to the desired position.

The makers will confer upon the profession a boon if they will devise a place for thermometers where they will be secure from breakage. Perhaps this end might be accomplished by placing a two-inch thermometer within and on the instrument side of one leg of the standards. There is also need of a portable, vertical circle that can readily be attached and detached from the telescope axis.

Telescopic power should be determined by the range required. In city work, where the range is short, the power should never exceed twenty diameters—a less number would be better. High power instruments will not focus on a range of four feet, and many good instruments are useless for a ten-foot sight. We are of the opinion that the foolish rage for high power instruments is over.

Inverting instruments gain in light power, and therefore in the distinctness of image. However, it is an open question if the advantage thereby

gained is not more than overcome by the inverted image. If at all times we saw everything upside down, this would be quite the thing.

The same may be said of the advantages of the position of the vernier, whether under the eye-glass or on the side of the instrument. After using verniers in either position for years, I fail to see any difference in the facility of reading or of handling the instrument. I do believe, however, that the brass lacquered finish is superior to the dark bronze finish now so universally used, the brass finish reflecting much more light, causes the verniers to be more sharp and clear, which is quite noticeable on dark, cloudy days.

The tendency toward small, well-made instruments is a good one. On account of the superior graduation and other mechanical excellencies, the instrument of to-day, reading to minutes, is superior to the transit of twenty years ago that read to ten seconds. For rapid, accurate work, the minute reading instrument is preferable to a finer reading one, on account of the greater certainty of correct and quick reading. Of late there has been a tendency to dispense with the needle. Some instruments are now ordered without needles. This is a mistake. Though far from an instrument of precision, the needle has its place on the transit. By its aid many useful problems can be quickly solved. It gives at all times the cardinal direction of a survey. Magnetic bearings are splendid checks on the correctness of angle readings. This is especially noticeable in running long, broken lines. A bearing always indicates the direction of a course, and a mistake in reading the bearing of one course does not destroy the indicated direction of the subsequent courses, as a wrong angle reading does. Thus it is that bearing observations will indicate the particular angle incorrectly read and frequently the correction can be made without re-reading the angle. The moral certainty this double observation gives is worth a great deal.

The idea has existed for years that high-priced instruments necessarily meant the best. Nothing could be more foolish. The lowest priced instruments in this country are manufactured by a concern of unexcelled facilities for superior workmanship. Other instruments may be better, but quality—not price, should be the criterion. As for myself, I have used for years a low-priced instrument with utmost satisfaction, and I have yet to see its superior. Now, whilst it is true that an experienced hand with poor tools may accomplish better results than a novice with the best implements, the use of best make of instruments is not herein disparaged. By all means insure your work with the best made transit obtainable. Let not its price but its quality be your guide.

In adjusting an instrument, the screws should be set up firm, but not enough so as to strain them. A cause for instruments getting quickly out of adjustment is setting the screws up without sufficient pressure.

There are many occasions wherein a level attachment becomes a great convenience. Elevations and grades then can be given that otherwise would have to be omitted. The question often arises as to the comparative degree of precision in elevations thus determined and in those of the Y level. Ex-

perience has demonstrated the fact that elevations can be determined as correctly by one method as by the other. The transit, on account of the double set of levels, requires considerable more care in handling than a Y level would. It is not always convenient, however, to have both instruments on the same work. It is therefore recommended that there be a level attachment with every transit.

The advocates to the contrary notwithstanding, the transit stadia wires are not to be relied upon for close, accurate line measurements, nor will they ever be; the fineness of their adjustments unfortunately prevents this desired accomplishment. However, it is surprising the degree of precision that herein has been attained; for instance, 1,500 and 2,000 feet have again and again been thus measured within 0.1 feet, or $\frac{1}{20000}$ of the actual. The standard of excellence should be within $\frac{1}{200000}$ of the absolute. It is only by use of the very best steel tapes, corrected for temperature, sag, etc., that the desired result can be obtained. The stadia is a most useful attachment in topographical and preliminary work, where high grade measurement is not required.

Now one word as to attachments. The transit should be as plain, simple and free from surplus parts as possible, consistent with the work required of it; hence the suggestion above of an adjustable vertical circle, and then it should ever be the duty of the engineers to see to it that the transit in all its parts is always in perfect adjustment.

And in conclusion let it be stated that the profession is under great obligations to our enterprising instrument makers for the excellence of their productions. We are astonished again and again when we contemplate their accuracy. Think of repeatedly turning off an angle from a five-inch or six-inch limb and striking with unerring certainty an object 2,000 feet away, as is frequently done, not to mention other wonderful evolutions it is capable of!

he Separate System of Sewers as Proposed for the City of Dayton, Ohio.

BY E. J. CELLARIUS, C. E.

A separate system of sewers, and perhaps the first in this state, is at esent in progress of construction in the city of Dayton, upon plans preared by Messrs. Cady Staley, of Cleveland Ohio, chief engineer, and eorge S. Pierson, of Kalamazoo Mich., constructing engineer, which plans ere subsequently modified by Mr. Rudolph Herring, of New York.

The necessity for sewerage in Dayton, particularly in the older and usiness portions of the city, was apparent, yet there was much opposition eveloped when it was finally agreed to sewer District No. 1, which practic-lly embraces the territory just referred to. There had been no provision hatever for the disposal of sewage, except that all refuse was dumped into esspools sinks and vaults, which so thoroughly saturated the ground that n analysis of the water in any well in the older portion showed contaminaon The water from many wells, upon chemical analysis, disclosed the resence of from five to ten grains per gallon of organic matter. The Board f Health, in its annual reports, has for years past been calling attention to e grave and growing necessity of a system of sewers. In their last annual eport the following reference to the subject was made, presenting the sanitary view of the question

"The most important want and necessity of the city of Dayton at the resent time is, in our judgment, a thorough system of sewerage—some eans by which the liquid waste material may be conveyed outside of the ity limits instead of being run into the ground on our own premises. Pure ir, pure water and a dry soil are the three great needful things for the althfulness of a city. The measure of a city's healthfulness is not her ortality rate, but is rather that of the healthfulness of her people, and their eedom from disease. While the mortality rate of our city is low, much ower than many of the cities of this country, yet it cannot be said that its ealthfulness is of the best. The diseases known as zymotic are on the increase with us, notably diphtheria and scarlet fever. Statistics clearly show at this class of diseases flourish where bad air and filthy surroundings are und and this bad air, impure soil and filthy surroundings cannot help but xist where sewerage water of all kind is run into the ground, and over hich we build our houses and eat and sleep and fancy ourselves secure. e do not desire to multiply words on so important a subject, involving so early the welfare of our city, but we do wish to most emphatically assert at the present condition of things as regards the present soil saturation annot help but be productive of great evil in the near future."

Yet there are many in Dayton who staunchly contend that, owing to the immense beds of gravel which compose the sub-soil underlying the city, that Dayton does not require sewerage; that these great gravel beds are periodically flushed by a rise in the river, and are thus cleansed of the impurities. But the fallacy of this theory was clearly shown by the excavations recently made for the sewer in the thickly settled portions of the city, many pockets of gravel being discovered which had been perfectly blackened by neighboring cesspools and vaults.

It might be well by way of introduction to give a general view of the situation at Dayton. Its population is about 65,000, lying on both sides of the Miami river. Although Stillwater flows into this stream about two miles north of the city, and Mad river and Wolf creek unite with it within the corporate limits, it is still, with all these tributaries, a shallow stream three-fourths of the year, requiring all sewage to be carried below the city limits. The ground is so low in the old or central portion of the city, in North Dayton, parts of Riverdale and Miami City, that high levees are necessary to protect them from overflow during times of high water. This seriously complicates the sewer situation. A number of considerations have led to the adoption of the separate system of sewers for Dayton, as the most feasible and practical, the chief one being that the storm water is already provided for by an efficient system of surface drains, and also a number of storm water sewers. Besides, this system will be much cheaper than a system of combined sewers.

The plan proposed and already partially adopted contemplates three main sewers: Two on the east side of the Miami river, viz., the Perry street main and the Monroe street main, which join each other opposite Bayard street and have their outlet in the middle of the Miami river opposite Apple street. To this outlet will be conveyed the sewage from all that territory east of the Miami river, both north and south of Mad river, and also all the territory lying north of Wolf creek and west of the Miami river. The other is the Washington street main, on the west side of the Miami river, and has its outlet near the first. Both outlets are favorable points of discharge, a tail race flowing into the river just above them.

The Perry street main has a population of 20,900 tributary to it. It consists of a forty-two-inch brick sewer from the outlet to the junction of Bayard and Longworth streets. The axis of the main sewer has a grade of 1 in 1,300 feet. This is properly the outfall sewer, the Monroe street main joining it at this point. From there it is continued as a thirty-six-inch brick sewer to the junction of Fourth and Perry streets, by way of Longworth, Carrie and Perry streets; then up Perry street to Third street as a thirty-inch brick. Here it receives a tile sub-main twelve inches in diameter laid west on Third to Roe street, where two ten-inch tile sewers unite.

The original plans contemplated a pumping station at this point to force the sewage from this sub-main and its laterals into the main sewer. The

total lift was nine and one-half feet. This is one of those low points in the city, in each of which the original plan contemplated a pumping station. There were five in number, viz.

(a) At the head of Ludlow street, for part of Riverdale.

(b) At the intersection of First and Mill streets, intended for North Dayton.

(c) At the foot of Germantown street, for the part of Miami City bordering on the river.

(d) At the intersection of Brown and Monroe streets, for the low territory lying along the Miami canal.

(e) At Roe street for the low territory in the old part of the city.

The city commissioners, however, regarded pumping stations as objectionable, besides entailing an annual expense upon the city, which they desired to avoid, if possible. They consulted Mr. Rudolph Herring and requested him to examine the plans in general, as prepared by Messrs. Staley and Pierson, and, if possible, suggest a modification by which the pumping of sewage could be simplified or avoided. In his report, Mr. Herring highly commends and approves the plans previously prepared. He further regards it as practical to deliver all the sewage to the proposed outlet without pumping at any of the five stations proposed, although he gives the following relative disadvantages which would arise:

(1.) The outlet would be about two feet lower in the proposed plan. It would still be high enough, however, to discharge at ordinary levels of the river. At other times pumping would have to be resorted to near the outfall, if backwater, due to the high water in river, becomes objectionable.

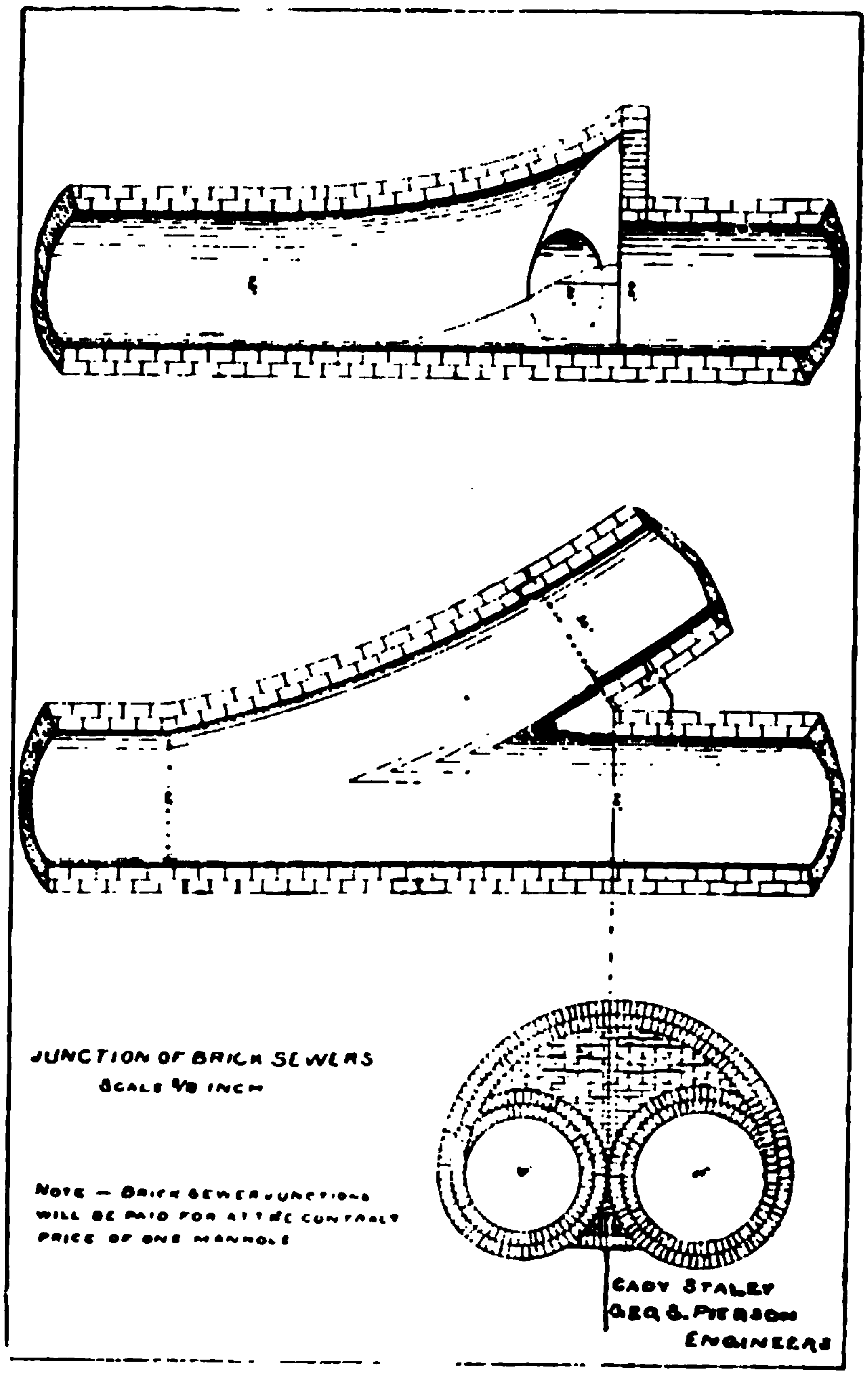
This necessity for pumping near the outfall would alike exist in the plan proposed by Mr. Staley.

(2.) The sewers would be shallow at a number of points. In fact, to secure a covering of three feet over the pike, it would be necessary to raise the low portions of Sycamore, Lafayette, and, possibly, one or two more streets to the extent of one or two feet. An inspection of these localities shows this to be quite practicable. If it is found that a covering of three feet will answer in these low places, then it is feasible to remove the sewage to the river without pumping.

(3.) The main sewer would have a slightly decreased grade over that in the plan. Instead of 1 in 1,000 feet, the fall would be about 1 in 1,300 feet.

While this decrease causes a slight diminution in the velocity of the sewage, yet this velocity will be quite sufficient, if the sewer can run from one-fourth to one-half full. To enable this to be accomplished, I am informed that sufficient water can be obtained for the purpose from the Miami canal, until the increased population supplies enough sewage. The admission of this water will, besides, keep the main sewer in a cleaner condition than it would be in the original plan, even with a slightly better gradient, because it would be a long time before the main in the latter case would run one-fourth full of sewage.

The second disadvantage, due to the avoidance of pumping, is really the only one which I should consider serious, and it can be left to yourselves to decide whether you consider a depth of three feet at the points mentioned sufficient for the properties or not. If you think it is not enough, then pumping must be resorted to. For sewage removal alone, this depth, in my opinion, would be sufficient in your city.



The plans already prepared were then modified according to these suggestions.

The main sewer referred to on Perry street continues at a grade of 1 in 1,000 feet, as a thirty-inch brick sewer to First street. Here it changes its direction 90°, and runs from Perry street to Wilkinson on First street, as a twenty-four-inch brick sewer with the same grade, where it receives three sub-main sewers.

(1) An eighteen-inch tile sub-main laid at a grade of 1 in 1,000 feet up First street from Wilkinson to Webster, passing under the Miami canal by an inverted iron syphon. From Webster street to Keowee street, and then at right angles up Keowee street to the river, it is laid with the same grade as a fifteen-inch tile. Before reaching the river it again passes under the Miami canal by an inverted iron syphon.

Provision is made at the foot of Keowee street for flushing the sewer by connecting it with the hydraulic, so that the sewer will have a sufficient depth of flow to secure the required velocity. This arrangement will be continued until the sewage of the city will be sufficient to perform this same duty. The main sewer, when running half full, will have a velocity of 135 feet per minute. The sewage from the territory north of Mad river is brought across this stream to the sub-main on Keowee steet by an inverted iron syphon.

(2) A twelve-inch tile sub-main is laid north on Wilkinson from First street to the river. Here it receives the sewage from Riverdale, through an inverted iron syphon. A ten-inch and twelve-inch tile unite at this point, on the north bank of the river. The twelve-inch tile is laid east to Main street, and then north on Main street. The ten-inch tile is laid west on Lehman street to Forrest avenue.

(3) A twelve-inch tile sub-main is laid at a grade of 1 in 800 up Bridge street to the river, and then across the river by an inverted iron syphon with a hydraulic grade of 1 in 400 feet. It is then continued west on River street as a ten-inch tile.

The Monroe street main has a population of 30,000 tributary to it. Beginning at the head of the outfall sewer, at the intersection of Bayard and Longworth streets, a brick sewer forty inches in diameter is laid at a grade of 1 in 1,000 feet up Bayard street to Main street; then south on Main to Monroe street; then east on Monroe street to Brown street. From this point it is continued, with the same grade, as a thirty-six-inch brick sewer up Monroe street to Wayne avenue, from Wayne avenue it is continued as a thirty-inch brick up Miami street to Fifth street. This main sewer has four sub-mains

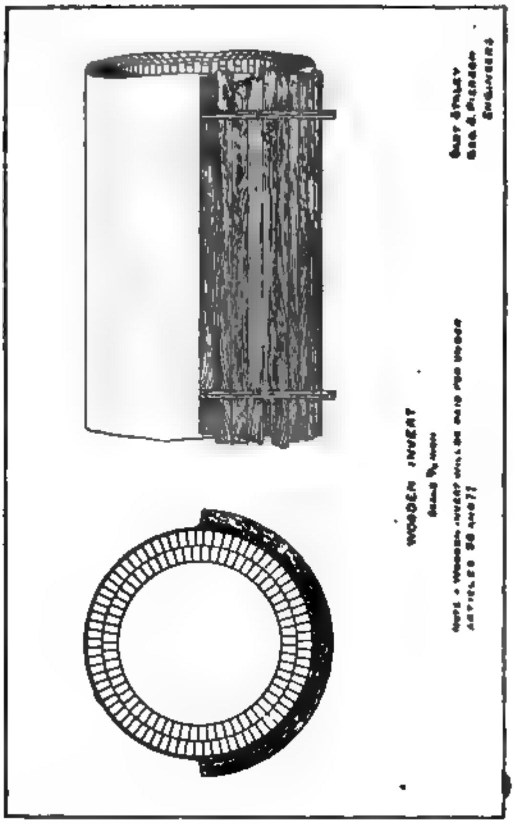
(1) At Brown street it receives the contents of an eighteen-inch tile sub-main, laid north on Brown street to Green street, and from Green street to Fifth street as a fifteen-inch tile, this sub-main collects the sewage from a low-lying and densely populated area extending north along the Miami & Erie canal, it will have a low grade, but sufficient when the sewer is running half-full, and this is provided for by connection with the canal.

(2) At Richard street it receives the contents of an eighteen-inch tile sub-main, having a steep gradient and extending east to the corporation line

(3) At Fifth street it receives the contents of a fifteen-inch tile sub-main, with a steep gradient, and extending east to the corporation line.

(4) At Fifth street it receives the contents of a twelve-inch tile sewer, laid north on Montgomery street to Third street.

The Washington street main has a population of about 9,200 tributary to it. From the outlet on the west bank of the Miami river, opposite Apple street, a thirty-inch brick sewer is laid at a grade of 1 in 1,000 feet up to

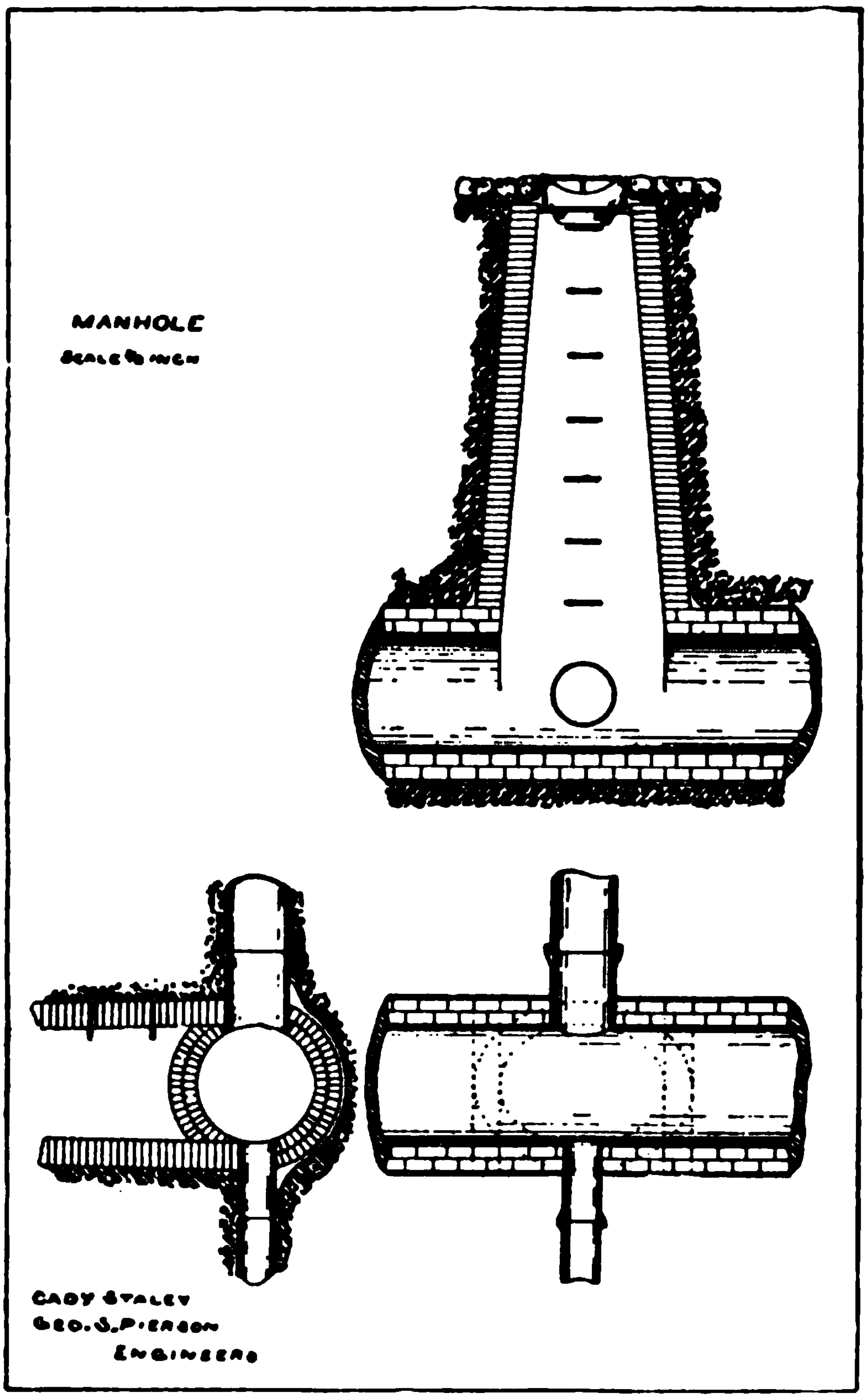


Washington street, and thence west on Washington street as a twenty-four-inch brick to Germantown street.

Here two sub-divisions unite. A fifteen-inch tile sub-main is laid up Hawthorne street to Fifth street, at a grade of 1 in 600 feet; then west on Fifth street to Conover, and up Conover a twelve-inch tile, at a grade of 1 in 300 feet. Another fifteen-inch tile sub-main is laid up Germantown street to Broadway, at a grade of 1 in 600 feet. All the territory lying north

and east of the part last described, and bordering the Miama river, is low territory and the grades must of necessity be flat. A sub-main laid along the west bank of the river will carry the sewage from this territory into the main sewer at the foot of Washington street.

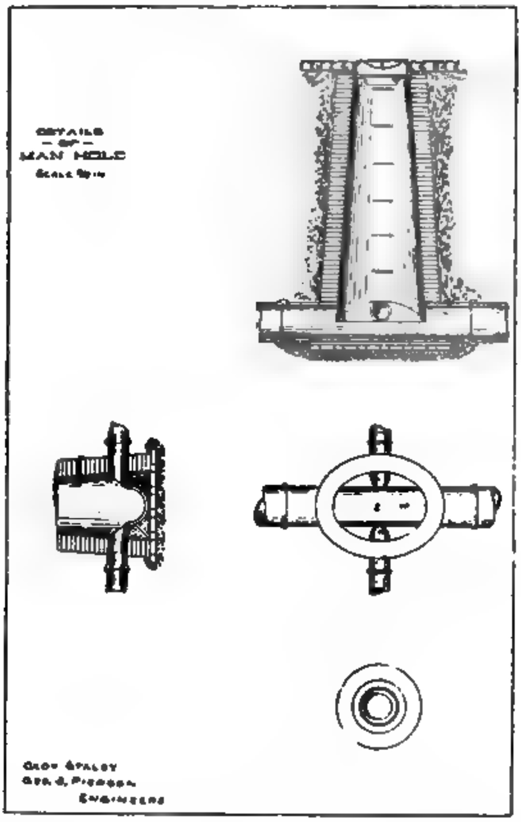
About the 1st of November, 1890, the contract for laying the sewers in the first district was awarded to the lowest bidder, Mr. Bruno Ritty. This district is bounded on the north and west by the Miami river, on the east by



a line drawn half way between Jefferson and St. Clair streets from the river south to Sixth street, and on the south by Sixth street. This comprises the business portion of the city.

The work of construction on the main sewer was begun about the 1st of December, 1890, at station 31 at the intersection of Longworth and Eaker streets, 3,100 feet from the outlet.

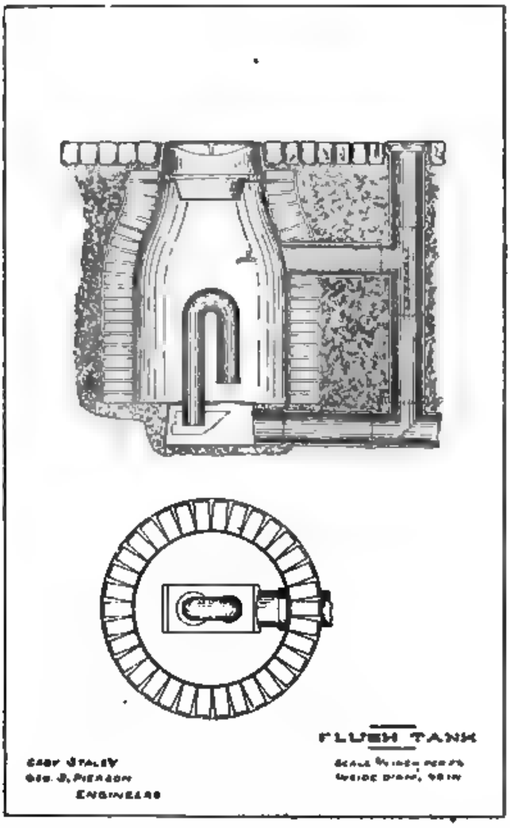
From this point the sewer was built northward. A centrifugal pump throwing a full five-inch stream was needed to keep the trenches free from water. When the pump is stopped the water rises to about the springing line of the arch. Underneath the main sewer two six-inch tile drains are being laid one foot apart, with six inches of gravel intervening between the top of the tile drains and the bottom of the exterior portion of the sewer,



leaving two feet between the grade lines of the sewer and tile drains. The trenches for the main sewer vary in depth from ten to twenty feet. For the laterals from three to twelve feet. The laterals consist of eight and ten-inch tile sewer pipe with grades of .3 feet, .4, .5 and .8 feet per 100 feet. The minimum grade is .24 feet per 100 feet.

Manholes are provided for at all street intersections, and wherever two

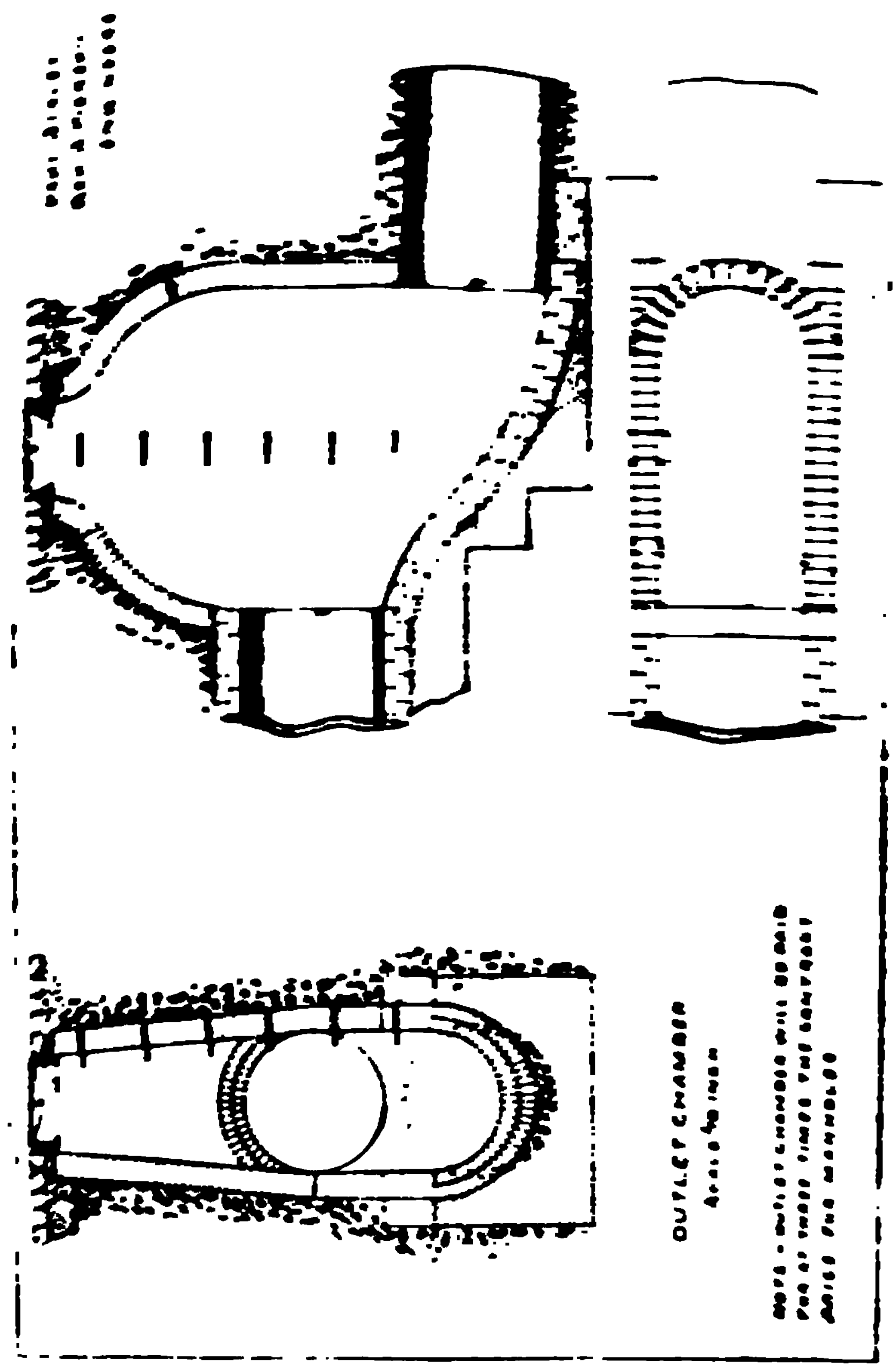
or more sewers unite. They are constructed of hard brick with an eight-inch wall laid in cement mortar and plastered outside with cement mortar and washed inside with pure cement. They have a perforated cast iron cover weighing 350 pounds. The contract price is $25.10. Automatic flush tanks are placed at all dead ends of laterals and will be constructed of hard-



burned bricks laid in cement mortar, so as to be water tight. They are plastered outside and inside with cement mortar. Their inside diameter is forty inches, and they will discharge one hundred and forty-five gallons once in every twenty-four hours, requiring from ten to fifteen seconds for each discharge, according to the capacity and grade of the sewer.

The contract price for sewering District No. 1, the only district un ler contract now, was $66,175.25. This sewers twelve miles of streets, and in

[illegible] feet of [illegible] sewer to be used in connection with the Monroe street main, besides [illegible] feet of eighteen-inch sub-mains extending east of District No. [illegible] at this time for the purpose of connecting with the [illegible] for flushing purposes. The engineer's estimate for District No. 1 was $[illegible].



At the outfall of the sewer on the levee at the foot of Longworth street a pumping station will be erected, the contract price for which is about $10,000. This station is to be used only in case of high water, when the main sewer will be locked at this point. The sewage collecting will then be forced into the river.

Bids for Construction of Sewers in Dayton, Ohio.

OPENED OCTOBER 13, 1890.

PRICE PER LINEAL FOOT.

BIDDER'S NAME.	PIPE LAID.							DRAIN TILE LAID.				BRICK SEWER.			
	18 inch	15 inch.	12 inch.	10 inch.	8 inch	6 inch.	5 inch.	6 inch	5 inch.	4 inch.	3 inch.	42 inch.	40 inch.	36 inch.	30 inch.
Estimated Quantities	5600	100	2800	7400	35000	1000	5000	5000	1000	1000	2000	1600	25	3300	2100
Frank Whitely, Springfield, Ohio	1 60	1.25	1 10	1.00	.65	.55	.55	.04	.03	.02	.02	3.90	3.90	3.80	4.00
D F Minehan, Springfield, Ohio	.77	.52	36	.30	.23	.13	.11	08	.07	.06	.06	4 00	4.00	4.00	3.50
John Munger, Dayton Ohio	60	50	33	.26	21	.14	.12	.05	.04	.03	.023	2 39	2 34	2 05	1.70
Robert J Paul, Dayton, Ohio	.67	.53	.43	.37	.24	17	.14	12	.095	.09	.09	2 90	2.90	2.55	2.20
Bruno Ritty, Dayton, Ohio	76	52	40	.33	23	.18	.16	.14	.12	.10	.08	2.78	2.41	2.25	2 05

	PER LINEAL FOOT. EXCAVATION								Repairing	Prices Each.			Iron Pipe—price in Tons.	Embankment, cu. yds.	Clay Puddle, cu. yds.	Total Bids.
	-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20		Man Hole.	Lamp Hole.	Flush Tanks.				
Estimated Quantities	12000	14000	22000	10000	3000	2000	1000	100	1500	180	200	60	110	3000	100	
Frank Whitely	.10	06	06	.06	.20	.20	.20	.20	25	20.00	3.00	25.00	60.00	60	1.50	$92,987 50
D F Minehan	23	.37	.39	60	90	.95	1.08	1 30	.45	34.00	5.00	21 00	55 00	.40	1.25	88,782.00
John Munger	20	35	.40	.60	1.10	1.20	2.00	2.50	12	25 00	3 00	25.00	38.25	.30	1.00	71,069 00
Robert J Paul	24	40	.44	59	85	1 00	1.24	2.25	.70	34.00	9.00	85 00	57.00	.67	1.40	88,294.50
Bruno Ritty	.16	20	.26	.37	.45	.63	.96	1.04	.15	25.10	9.35	23.00	50.00	20	.50	66,175 25

Notes on the Construction of Sewers.

BY CHAS. A. JUDSON, SANDUSKY.

The following notes are submitted to you, not with the idea that they contain anything startling or that may be even new to you in the field of sewer construction. I believe that we progress in this, as in the other provinces of our profession, as we study and compare the results of our experience. It is for this purpose, therefore that I offer these observations as a sort of outgrowth of some seven years' experience in designing and constructing sewers.

THE DISTRICT.

The size of the district depends largely, of course, upon the topography and its location with reference to a general outlet. In a city like ours, where the elevation does not exceed thirty feet above the bay, the districts are nearly all small, and to define them is an easy task. A simple way has been to build a main sewer up each street that runs to the bay, with laterals to the center of the blocks on each cross street. As far as practicable this has been done. In a portion of the town a rocky ridge extends parallel with the bay shore, some fifteen hundred feet from it. This ridge is as high or higher than the land lying back of it. To cut a main through this ridge at each street deep enough to drain the region back of it would be an expensive arrangement. It has been found best therefore, because more economical, to combine several streets back of the ridge into one district, and cut but one main through it, draining the balance of the ridge and the territory below it with shallower sewers. The main in this case is, of course, larger, but there is but one expensive and deep cut through the rock. The surface soil is clay; beneath it is a blue and gray limestone which crops out at some points, and is some twelve or fifteen feet below the surface in others. There are few sewers in the building of which rock has not been encountered.

Steam drills are used for making the holes for blasting. These holes usually alternate from side to side of the trench, and vary in depth from one foot to four feet, and in distance apart from fifteen inches to three feet, according to the nature of the rock. Dynamite is used almost exclusively for blasting, being usually fired with a battery. A difficulty encountered in excavating rock in trenches is that but one or two holes can be fired at the same time, owing to the narrowness of the face, as it is termed. While blasting, the trench is covered closely with heavy plank and timber. Elm has been found the best material for this purpose, owing to its toughness.

GRADES.

Our grades in some cases are light, though there are but few instances in which the theoretical velocity of flow is less than two and one-half feet

per second. The actual maximum is one and four-tenths feet per one hundred for a three-foot sewer.

When they can be regularly flushed from hydrants or in other ways, even lighter grades than these can be ventured, depending, however, upon the situation. I believe that no lighter grades should be used if it is possible to avoid it. In villages where the population is not dense and where its growth is slow, such grades may work satisfactorily. In the case of Port Clinton, an adjacent town, grades as light as one-tenth foot per one hundred feet are used, because no greater inclination can be obtained, as the town is in a plain, the greatest elevation of which above the lake does not exceed seven or eight feet. The sewer consists of pipe from six to fifteen inches in diameter, with man-holes at intervals of two hundred feet, and catch basins every four hundred feet. The sewer system has been in operation six years, and has worked satisfactorily. As there are no water works, they depend upon storm water alone for flushing the sewers.

SYSTEMS.

We admit storm water into all sewers for these reasons: (1) In rock such as we have the trenching is the chief item of expense in the construction of a sewer. By combining the street water and the sewage proper therefore, nearly the entire cost of an additional drain is thus saved. (2) The storm water serves the additional purpose of flushing the sewers. That it does flush them is, in a measure, proved by the fact that we have had no stoppages where the sewers are connected with catch basins. In fact, the object of the separate system is said to be "to convey the rain fall to the sewers and the sewage to the land." With us there is no necessity for seeking either of these ends, as the bay is too large to be polluted by this means and the sewage is not worth saving.

CAPACITY.

The sewers are intended to be large enough to carry the maximum rainfall, together with the natural sewage. Provision is made for a rainfall of one inch in ten hours, together with one hundred and ten cubic feet of sewage per hour per acre.

PIPE SEWERS.

We are building sewers of pipe, brick and stone. Vitrified, salt-glazed sewer pipe are used in sizes from eight to fifteen inches in diameter. No pipe is now used above that size from the fact that they are liable to crack in handling and require so much care in laying to prevent breaking from the weight of fresh filling. Eight inch pipes are used only for laterals in cross streets not exceeding three hundred feet in length. Six-inch has been used quite largely for this purpose, but as stoppages have been quite frequent in them, nothing smaller than eight-inch is now used.

Each pipe is tested by sounding and carefully examined for cracks, defects in glazing, softness, roughness, etc.

Any pipe more than one-half inch out of round is rejected. The pipe should be fitted on the bank and no chipping allowed. Care is taken that the pipe be laid in straight lines between manholes.

It is laid in sections of not less than twenty-five feet before covering, to prevent the throwing back upon the pipe of the lower foot or two of excavation. This evil practice, to which the average contractor is very prone, causes mud to accumulate in the pipes themselves, and prevents the proper setting of the cement in the joints. The joints should be carefully filled with pure cement, both on the bottom and top.

Six-inch wyes, closed with earthenware stoppers, are put in so as to accommodate buildings, and at intervals of thirty-three feet along vacant lots. Four-inch wyes only were at one time used for house connections, but, as it is sometimes necessary to make six-inch connections, and the average citizen prefers that size, nothing but six-inch is now put in. In re-filling, earth should, of course, be carefully tamped about the pipe and to a depth of twelve inches above it. The balance of the filling, if of clay, should be tamped or puddled, providing the street is to be used for traffic. When the excavated rock is used for filling, stones should not be larger than twelve inches in diameter. I have found that stone filled into a trench in this way forms an arch just above the pipe and takes the weight of the filling off from it. In fact, a broken pipe in a rock fill has seldom, if ever, been reported by those making excavations for private connection.

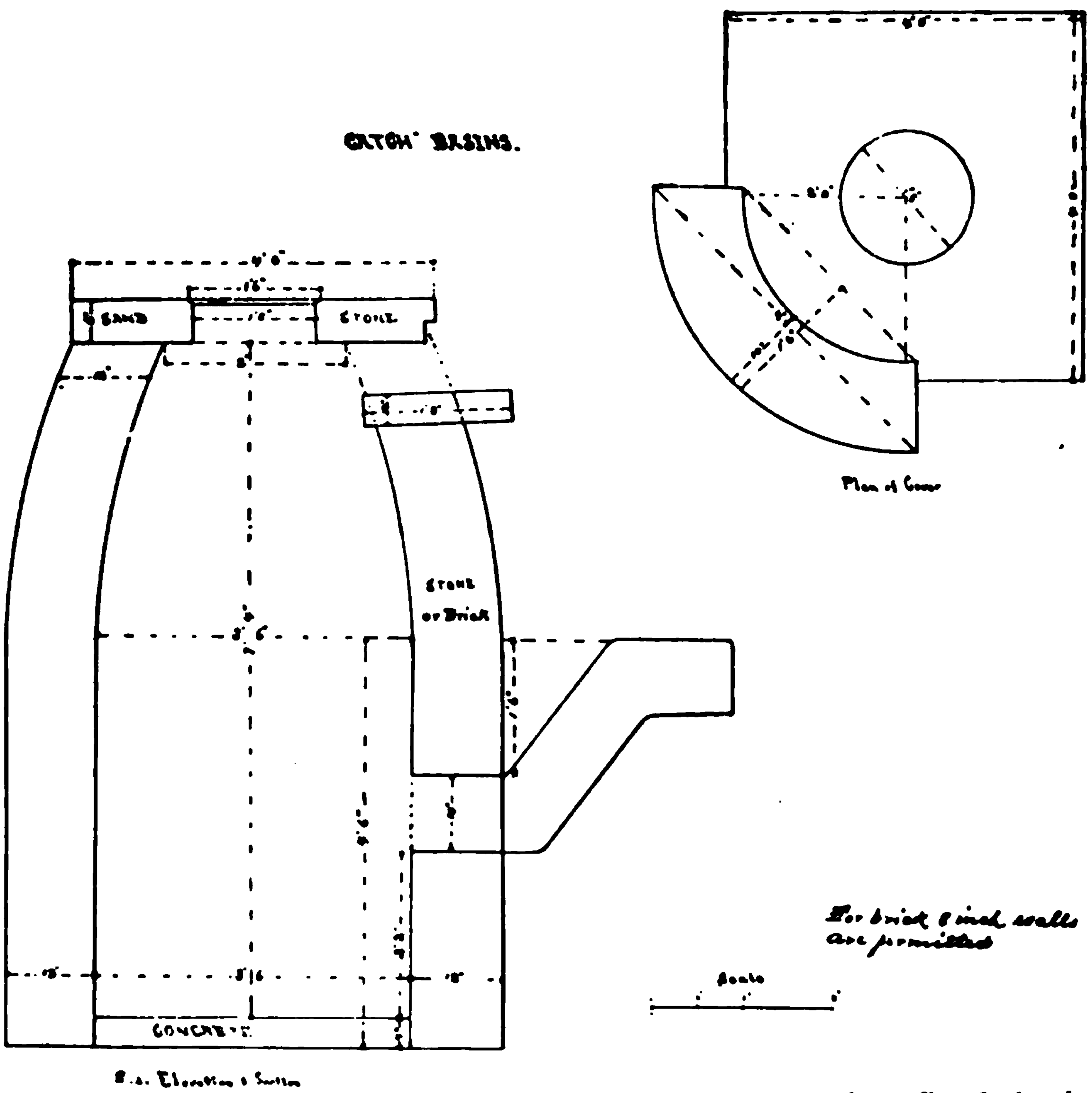
BRICK SEWERS.

As I have said, pipe is not used for sewers above fifteen inches in diameter. Our brick sewers range in size from two feet diameter, circular, to three feet by four feet, egg-shape, all with four-inch ring. The circular has been adopted where the flow is somewhat uniform, while the latter form is used where it is likely to be more variable. The brick are thoroughly soaked and allowed to drain a short time before laying. The lower half of the sewer is built in sections of twenty-five feet in length. Each course is laid to a line fastened to a templet ahead and the finished segment behind. All filling behind, whether in earth or rock excavation, is done with mortar, concrete or stone masonry, no loose sand being allowed. The centers for the smaller size of sewers are so constructed as to be set and released by means of levers assembled at one end. By tamping clay tightly behind the arch to a depth of ten or twelve inches, the center can be immediately removed. The masonry should be left in this condition until the mortar has well set before re-filling the balance of the trench. In this way but one center for the arch is necessary. In earth, the excavation is made just the shape of the lower segment of the ring. In rock, the excavation is made at least eight inches outside and below the ring of brick and then built up with concrete or masonry to the required shape.

STONE SEWERS.

Stone has been used for sewers whose sizes run from four feet by five

feet four inches up to five feet six inches by seven feet four inches, the ring varying from eight inches to twelve inches in thickness. The stone is the native blue limestone, often quarried along or near the line of the sewer itself. It makes a substantial and cheap sewer. We are now building one of this material five feet six inches by seven feet four inches, and the contract price for the masonry is only $2.79½ per lineal foot of sewer, or about twelve and one-half cents per cubic foot. The stone are hammer-dressed and are laid in substantially the same manner as brick. The stone is more or less susceptible to the action of frost, but, as it is nowhere exposed to it when used in sewers, this quality does not injure it for that purpose. Manholes of either brick or stone are placed at intervals of from two hundred and twenty-five to two hundred and fifty feet, and at each change of line or grade. They are four feet in diameter at the bottom and taper to the top to fit a ventilated



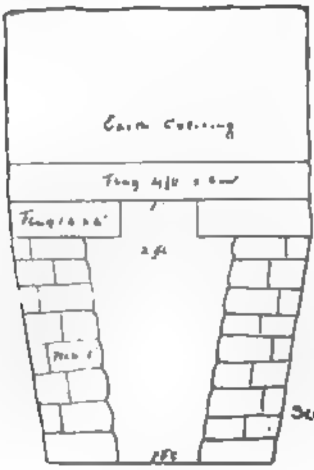
cover, which weighs three hundred and twenty-five pounds. Catch basins are of brick or stone, are three and one-half feet in diameter, and taper to fit a stone cap four feet square. They are of the form shown on the accompanying plan. They are fitted with earthenware half traps, and are plastered

with nearly pure cement. They are always connected with the manholes in pipe sewers, and have ten-inch pipe connections. They are so placed as to best receive the surface water of the streets and to flush the sewers. I prefer this form of basin to that form which allows everything that washes into it to be discharged into the sewer. It certainly arrests a large amount of matter that would otherwise find its way into the sewer to clog it. The expense of keeping them clean in Sandusky for the last three years has not exceeded sixty-five cents each per annum.

GRADE STAKES.

Grade stakes are set with a transit along the bank on one side only, and twenty-five feet apart. They are placed from four to six feet from the center line of the sewer, and are driven flush with the surface of the ground, so as not to be disturbed by the timbers used for covering in blasting or by the shovels of the workmen.

When the trench for a section or two is ready for the pipe, scantling are placed across it at each stake raised sufficiently above the latter so that each cross-piece shall be the same distance above the grade, and then carefully leveled. A line is then attached to them located over the center line of the sewer by measurements from the stakes. The proper distance is then laid off on a pole and the pipe are rapidly laid by bringing the mark to the line when the pole rests on top of the pipe. The alignment of the pipe is obtained by using a plumb from the horizontal line or by a level on the side of



Scale 1:12

the measuring pole. There is no difficulty in using the top of the pipe to grade by if the pipe are properly inspected before going into the trench.

As a matter of curiosity, I have here a specimen cross section of sewers

that were built about 1870. They were usually made of dry masonry, though mortar was sometimes used. They have given much trouble, though the grades have been good, from the deposits that accumulate in them, and by reason of the readiness with which the sewage and gases escape through the rough walls and pollute the adjacent space. That these sewers were not intended to convey sewage is evident from an ordinance in force as late as 1872, which provides that no vault or closet shall be connected with any of the sewers of the city.

In conclusion, permit me to say that this work should be done under the constant supervision of a competent and faithful inspector. To prepare elaborate plans and strict specifications is one thing; to have them followed as the work progresses is quite another.

Another suggestion is that none but licensed sewer diggers be permitted to make connections for private sewers, and they should be carefully watched. Sewers thus built and taken care of will give little trouble.

Separate System of Sewers.

BY J. B. WEDDELL, C. E., GALION.

I have undertaken in this paper to set forth, in a practical manner, the building of the sewers in the eleventh sewer district of the city of Galion, O. What is contained herein is more particularly directed to my brethren who are beginners in the profession, and who, I believe, are wanting to know, not only what is *doing*, but *how* it is done.

Much has been, and much may be said on the subject of sewerage and upon the different systems. That I will leave for others, and try, in a brief way, to set out, in detail, the construction of our work.

All but about 3,200 feet belongs to the separate system (so called), which consists of two lines of pipe laid in the same trench, one for sewerage proper and the other for cellar drainage only, and was advised by Col. George E. Waring.

The main trunk is built of twenty-inch sewer pipe, is about 1,600 feet long, has a fall of three-tenths of a foot per hundred, and empties into Whetstone creek outside of the city limits.

The sub-main is built of fifteen-inch and nine-inch pipe. The fifteen-inch receives street water and has an average fall of one and five-tenths feet per hundred. The laterals are all eight-inch pipe, except one which is ten-inch and eight-inch. The cellar pipes are four-inch and six-inch sewer pipe.

The work is all in open trench, with an average depth of ten feet—greatest depth fourteen feet—mostly through gravel and coarse sand, with considerable quicksand. Much water has been encountered, in some places being impossible to entirely free the trench from it when laying the pipe. Owing to the loose nature of the excavations, the banks were treacherous and required to be closely sheeted from top to bottom. The work was let to W. L. Porter, of Lima, O., at eighty-three cents per lineal foot for the greater part of it, and ninety-two cents per foot for the balance—all complete. First-class materials and labor required.

The outlet is protected by a wall of masonry sixteen feet long, eight feet from base to top, and two feet thick. The outfall is upon a bed of paving made of block stone one foot deep laid upon a bed of gravel ten inches thick. This paving has a width of eight feet, is concave in form, and extends from the wall to, and below, low water, a distance of about eight feet.

PIPE LAYING.

The levels were placed above the surface, instead of in the bottom of the trench, and were arranged in the following manner: Two posts, two inches square and about five feet long, were driven into the ground on each side of the trench, six or eight feet apart. At a distance of about thirty-three feet

another pair were placed, and so on until one or two hundred feet of the work was staked. A board one inch thick and three to six inches wide, with a straight edge and long enough to reach from one post to the other, was then nailed to the pair at the beginning or outlet of the work, and far enough above the surface to be out of the way of letting down pipe, the upper edge being straight and level. The grade was then run parallel to sub-grade, from the top of this board, and marked upon each pair of posts, and a board nailed thereon as before. A strong mason's line was then tightly stretched from the top of one board to the top of the next, over the center of the trench (this line was then parallel to sub-grade line). A rod or pole was then set perpendicular on sub-grade and marked where the line would cut. After the first pipe was laid, the rod was placed upon it immediately back of the bell or socket and again marked where the line would cut it. This enabled the superintendent, who handled the rod, to direct the depth of excavation and the laying of the pipe to a true grade. As the cutting increased or decreased and the parallel raised or lowered, the rod was lengthened or shortened, to correspond. Notes were kept of the length of the rod and its changes, which was tested from time to time.

To secure the pipe being laid in a straight line, another mason's line was attached to the grade boards in the true line of the work. A plumb line was suspended from this and let fall to nearly sub-grade immediately in front of the last pipe laid, which was then centered by this plumb line. After the pipe was fastened the plumb was raised to the surface, and taken out of the way until another pipe was ready.

The joints were sealed with pure cement. The mortar was placed in the socket of the lower part of the pipe, filling it almost flush with the invert for about one-third of its circumference, and, on entering, the pipe was raised as high as the socket would permit, and then allowed to settle in the mortar. This, also, keeps the inverts to true grade. The remainder of the joint was made in the usual way, and finished by carefully wiping out the inside. Gasket was used where necessary. I have in this way obtained the best work, the inverts—the part most needed, being well sealed.

The back filling was done with the best material—mostly sand and gravel—and well rammed until on a level with the top of the sockets. After twelve or fifteen feet had been laid, the laying of the cellar pipe commenced, which was done in the following manner. A board, not less than ten feet long, one inch thick and six or eight inches wide was laid on top of the sewage pipe in contact with the sockets and given a full, solid bearing along its entire length. Two strips, of the length of the board, one inch square, were securely nailed to the upper surface, and far enough apart to receive the sockets of the cellar pipe, and secure them from rolling or lateral displacement. Sand was filled upon this board, of sufficient depth to give a full bearing along the barrel of the pipe, letting the sockets rest upon the surface of the board. A six-inch pipe required a board eight inches, and a four-inch pipe one six inches wide.

All joints were carefully cemented and cleaned out in the manner above described. A little deflection was made in the line of direction as the lamp-holes in the sewage pipe were passed. On curves, shorter boards were used, and the strips, sometimes, left off.

Where more than one lateral entered a manhole, the cellar pipe connection was made outside. Lamp-holes for ventilating and other purposes were placed and carried up side by side with those of the sewage pipe.

Sealed T's were placed in each manhole, to be used as a place of observation in time of need. The line passes through the manhole a little to one side of the channel of the sewage pipe, upon a foundation of masonry built up from the bottom high enough to preserve the grade, and was securely walled in place. The pipes are intended to be entirely separated from each other in their currents, no sewer gas or sewage being permitted to enter the cellar pipe.

QUICKSANDS

were worked in the following manner: Twelve or fifteen feet of the trench were completely enclosed in a tight sheeting driven several feet below sub-grade, and well braced. The sand was then taken out a little below sub-grade, and, if it had considerable depth, piles of two by six-inch stuff were driven into solid bearings. They were sunk far enough below sub-grade and of sufficient number to receive and allow a plank two by sixteen inches to be spiked thereon, and form a solid foundation for the pipe. Two strips were nailed on the upper surface, far enough apart to receive the sockets and hold the pipe firmly in place. Back filling was of coarse gravel. Where the sands were less than two feet deep, the plank was used without the piles.

The sheeting of the sides of the trench was left in, as the work, if needed, could be reached with much less labor, and repairs made with more ease than if it was not there. Manholes were built of hard-burned brick, circular in form, eight-inch walls, five feet inner diameter at the base and for five feet above it, finished at grade of street with a cast iron frame and perforated cover weighing about three hundred and twenty-five pounds. Paving of stone blocks one foot long and six inches deep surrounded the frame, flush with the top.

The bottom, except the channel, was laid with flagstone three to four inches thick upon which the walls were started. The channel was formed of brick or half pipe, the flagstone resting on the margin and securely holding it in place. This flagging foundation had an inclination toward the channel sufficient that anything lodging thereon would be easily washed off. When the earth was soft, the stone flagging and channel was laid upon a plank foundation seven to eight feet square. They were placed from three hundred to five hundred feet apart, usually at changes of grade, direction, and at lateral junctions.

Lamp-holes were placed about one hundred feet apart between manholes, and terminated in a chamber of masonry at the surface. This cham-

ber, twelve by sixteen inches area and one foot deep, is divided into two parts by a partition, one receiving the cellar and the other the sewage pipe, and is finished with a perforated cast iron cover. No connection can be had between the air currents in the pipes until they have passed through the cover. The walls of this chamber are one foot thick and have their base below frost line. No part of the weight rests upon the pipes and any water entering the chamber finds its way down the pipes.

A T for a hand hole was placed between man and lamp-holes. All places of connection were closed with a vitrified cover, and sealed with cement. Automatic flush tanks were placed at each dead end (the upper end of each line). They were built after the manner of the manholes, and have a capacity of from three hundred to six hundred gallons. All mortar for masonry was made of one part of Akron cement and two parts of clear sand. All the work except about 3,600 feet was located in the alleys, which are sixteen and one-half feet wide.

Now, I would say in reference to this construction, that I have always found it difficult to get a man to fill the specifications, or enough of them to make good solid work up to the quality that is required. Contractors, as a rule, give me a very hard name. I know the contractor that we have on at the present time does, although the quicksands have bothered him a good deal; yet I have not been able to get him to do anything but about as he pleases. We find great difficulty in getting things to go on as they ought to go on. I would like to hear from my brother members on this. I will go home feeling better if I have the support of my brother members in insisting in carrying out these specifications. I would be glad to answer any questions I can.

DISCUSSION.

A Member—As I understand, no storm water gets in that upper pipe at all.

Mr. Weddell—No, sir; the cellar pipe connection was carried from the cellar pipe along the line of the cellar, and a trap there just before it enters the cellar, or in the cellar, as the case may be, as an additional safeguard.

Mr. Brown—Do you put in another line of pipe for your storm water?

Mr. Weddell—No, sir; we don't use the sewers for storm water.

Mr. Judson—You must be more fortunate than the average town, because, ordinarily, take a town where the territory is level, or almost level, and it is quite a serious problem how you will get rid of the storm water. We have to carry it a long ways some times. Sometimes we have to carry it several blocks before we can discharge it into a creek or body of water where we can get rid of it, and it is as much work to take care of the storm water as to drain the cellars.

Mr. Weddell—The object of this system is to be able to put it in in places that are not able to build the combined system. This does not cost very much, and it is a means of conveying the sewage away from the premises, and the storm water takes care of itself. Of course, if we had very heavy grades in places where washes would occur in streets, it would be better to drop it into the sewer and carry it off that way; but the object of this system is to enable the sewage to be carried away at a price which the people are able to pay for it. That is one objection, in some places, where they put in the combined system, is the tax placed upon the property.

Mr. Davisson—What is the difference in elevation between your two pipes?

Mr. Weddell—The difference of elevation is just simply the height of the pipe from which it is laid.

Mr. Davisson—The one is laid just above the other?

Mr. Weddell—Yes, sir; one is laid here, and a board on that, and another pipe right on here.

A Member—Is not the weight of this all concentrated upon the sockets of your lower pipe?

Mr. Weddell—This is all packed and filled full of dirt even with these sockets.

Former Speaker—So that the pipe does not rest wholly upon the socket of the lower pipe?

Mr. Weddell—No, sir; it is all filled up with dirt.

Mr. Wickenden—In making your house connections do you insist on ventilations?

Mr. Weddell—Yes, sir.

Mr. Wickenden—Well, if the cellar drain was ventilated in the same manner as the house drain, why should there still be a necessity for the cellar pipe?

Mr. Weddell—For this reason: You take the trap that traps the cellar, and it usually is unsealed by evaporation; it is not at all times that you have water passing out of the cellar to keep the trap sealed; that leaves an opening there, and if you are connected with the sewer the sewer gas enters the cellar; the object is to keep all sewer gas out of the cellar. The air in the cellar is usually warmer than outside, and sometimes warmer than it is in the sewer, and that makes a good place for a draft. I believe the history of the evils of that kind of work is that there has been more trouble occasioned from sewer gas getting in the cellars and basements than in any other way.

A Member—It seems to me there is another plan that will obviate that and not require the two pipes, and that is a plan I have adopted: I think instead of having a cellar drain have no cellar drain whatever; do not have your cellar connected with anything, but absolutely shut off from a drain; but put a drain entirely around your building outside, clear below the bottom of your cellar; that prevents any water getting into your cellar, and you

have no connection whatever. It is cheaper than to put in two pipes, and you are absolutely exempted from any contamination from sewer gas whatever I have that in my own house, and we have never had any trouble

Mr Weddell—That would do if your sub-soil is always all right, but that is not always the case.

A member—You must have some outlet for your drain.

Mr —— The outlet goes into the sewer.

Mr. Weddell—How would you do when it comes up in the bottom ?

Mr —— The drain outside is lower than the bottom of the cellar It is entirely below the basement of your cellar probably from six inches to a foot lower, so that your cellar is perfectly dry and no connection with any drain or opening into the sewer. My own house is the only one that I knew of constructed in that way. I know of some since constructed in that way, a regular tile drain put around the house about a foot lower than the cellar. No additional cellar drain is needed.

A Member—Wouldn't it come back from the main sewer into it ?

Mr. —— No, we have the sewer lower than your cellar, so that there is no tendency to come back in there there is more or less ground drainage which goes into this pipe and it has a tendency to keep it clean.

Mr Weddell—I would like to hear from other members on the subject I asked about a while ago—how you get along in putting in the work with your contractors

A Member—Mr President, in the first place, I have always made it a point to have a competent fellow on the ground for inspector that is one of the first conditions. If he does not attend to his business, turn him off and get another one, that is the first thing, and I have not in my experience—the contractors may be a little better up my way than in other sections of the country—had any serious difficulties with them. When they first start out on a job, you usually have some trouble with them for a week or two. Once in a while there is a man who knows more about it than you do. He can find a great many ways in which he can save himself money, and he thinks it would be just as good to the city, and it takes some time to convince him to the contrary occasionally, but, aside from that, I have had no difficulty with them The main expense in our sewers is getting the trenches opened. We have no quicksand. We don't know what it is up there. After the drainage is open, the contractor is so happy to think he has got it out that to spend a little more time in laying the tile is not much of an item. We have not much trouble in that.

Mr. Davisson—There is one matter I wanted to speak about in regard to the Dayton sewers Now I was speaking to the city engineer of Dayton, and he said this that when the gas pipes and the water pipes and all that class of pipes was laid, no record was ever kept in the city engineer's office, so that when they went to work on the sewers over there, the engineer who has charge of the sewers, told me that he went to work and staked out the sewers so as to avoid all these pipes as nearly as they could remember. They

had no references whatever to the lot lines of these old pipes put in or to the curb lines, and the result was that he hadn't a sewer in the town but what it was under some of these pipes, and, if they had a cave-in, the gas pipes would be mashed in, or else they would have to swing them up some way. I think it should be avoided, and it should be urged on city councils of every city to have a complete map of these things and have them kept in the city engineer's office. They would avoid all that trouble. I am confident these people will lose a greal deal more money in that work, by having their pipes damaged, than if they had had the city engineer to have laid out the work for them, and had a complete record kept of the exact distances every pipe laid in the streets was laid from the curb line, then they would have had none of this trouble at all. I would like to ask if that is the case in other cities.

A Member—I would say that in the sewerage of East Liverpool that there are in some of the streets as many as five natural gas lines, besides artificial gas that was put in before natural gas, making six lines on some of the streets. It became necessary in that city to put a great many of the sewers in the alleys, which is oftentimes a very good practice. But, in regard to a record of all the pipes, there should be insisted on a careful and accurate map of every city improvement, where water works, sewerage or gas, or any other kind of pipes. New York has been experimenting with that problem, which is now before them, for a long time, and they have now just the difficulty that has been spoken of. You will sometimes see a map, published in the Engineering News, showing the confusion of pipes at these street crossings. I will say that East Liverpool first put in the separate system, which he thinks was first put in at Dayton.

Mr. Weddell—I would like to have the experience of anyone on the working of quicksands.

Mr. Hoover—If Brother Seitz is not here and there are no quicksand men to answer the gentleman's question, I would like to hear from Brother Strawn on his troubles about recording surveys and whether it is at an end, and what the result has been. I would like to hear from him, if there is an interregnum in the business now to allow it.

This matter of Mr. Strawn's, together with some discussions that were accidentally omitted in their proper order following the papers, will be found at the end of the report.—[ED.

Permanent Drainage.

BY J. W. SEITZ, C. E., OTTAWA.

The practicability of drainage of land for agricultural and other purposes has long since ceased to be a question by all civilized nations, and we might refer to the edict of the Creator, on the third day of creation, as the earliest example of the necessity for the separation of water and land.

As the population of a country has become more dense, the necessity for the drainage of the more unfavored portions became apparent, and as "necessity is the mother of invention," the good work was begun. Although their notions of drainage were crude at first, our ancestors' efforts were rewarded more or less. Marked improvements have been made from time to time. The system of dykes and drains of Holland has produced one of the most fertile and populous districts of Europe. But the Romans were probably the first to employ covered drains. These were formed of wood or other substance, and were highly praised by Roman agricultural writers. The progress of covered drains had been very slow until about the middle of this century, when it was reduced to a system, in England, by a Mr. Smith, of Deanston. From this time to the present, rapid strides have been made in the use of under drains. These were not at first constructed with earthenware, but with wood, brush, straw or stone.

The tendency in drainage has been for the last quarter of a century towards permanency, and so far as the smaller drains are concerned the object has been pretty well attained. The drainage of small areas is well understood in many localities in this country, but could be greatly improved if at least the smaller outlet ditches were constructed in a more permanent manner. It is the object of this paper to chiefly treat of these smaller outlet drains, varying in length from one to three or four miles, or of still greater length, owing to circumstances. These may be placed under two classes.

First—Those which empty into streams or outlets which do not afford sufficient outlet without improvement.

Second—Those which empty into streams which afford sufficient outlet without improvement.

With the first class, nothing of a permanent nature can be done until a good outlet is secured. This must be had at almost any cost, unless we are still contented with the good old way of "digging out the fall in the upper course of the stream" every three or four years. But with a view to permanency and economy, this main outlet must be made one good and grand improvement. In doing this we must consider the factors of straightness, depth, width, flare of banks, and the removal of excavated earth, as well as such portions of banks likely to slide into the ditch, to such distance as to

secure the best results. Each of these factors, and others entering into the betterment of the outlet, must be duly studied with a view to permanency, for this outlet will cost something and must not require improvement every few years. It must, and will, stand for many years, if properly constructed and cared for. Having secured a good outlet for drains of the first class, and Nature having provided us outlets for those of the second class, we should now devise some means to construct these shorter ditches in such a manner as to get rid of the constant cleaning out of these direct outlets for farm drains. The latter should flow freely throughout their entire length all the time. The mouths of tile drains should not be obstructed by backwater, or by sediment allowed to accumulate in the outlet. This backing of water in drains for even a few hours may seriously injure if not entirely destroy a growing crop. Evidently, to avoid this calamity, the outlet must be deep enough and have sufficient fall to convey the water as fast as it reaches them to the larger outlet mentioned above.

The construction of these smaller ditches, so as to secure the proper depth and fall, will often require deep cutting, as the natural fall is often greatest at or near the outlet, and as deep, open drains are expensive and require constant attention to keep them free from obstructions "too numerous to mention," we must overcome these obstacles in another way. The use of tile or sewer pipe would certainly overcome many of the objections to open drains. The depth would be always the same. The capacity, when properly constructed, would be a constant quantity. The sediment would be reduced to a minimum.

But there are some objections to tiling or sewering these drains. The first and greatest of all is the cost of tile or sewer pipe. The incapacity to carry all the water at certain times and other smaller objections will be raised. The expense of tile or pipe will vary, of course, with the size of the pipe, not exactly in proportion to the squares of their diameters, the larger being the cheaper, according to capacity, as may readily be seen by examining price lists of sewer pipe companies. But would it not be better to increase the cost of the improvement considerably than to be constantly overhauling the old, sluggish watercourse and running the risk of losing a crop every few years? By increasing the depth we will increase the capacity so that the pipe need not be so large as if laid at the usual depth of open drains. Let the pipe be laid from one to three feet deeper than the usual depth of these open drains, thereby allowing the farm drains to flow freely all the time. In case of an unusually heavy rainfall, the water might possibly gather in faster than the pipe could discharge it, forming a head of a foot or more of water for a short time. But the pressure created by this head will increase the flow of water and have a tendency to remove all silt that may be deposited in the pipe, leaving the drain in as good or even better condition than before such flood. There can usually be to advantage a shallow, open drain left over or near the tile drain. This can be formed as the case may require as to depth and slope of banks, but usually should be from one

to three feet in depth, with banks sloping so as to be easily crossed with wagon, mower or plow.

The aggregate amount of cost of location and the amount of time spent in attending hearings and sales will be no trivial sum in a period of twenty or twenty-five years.

In the improvement of watercourses of the first class as arranged above, no attempt should be made in piping until a good, deep outlet is secured, or there will be a demand in a few years for the removal of pipe from the ditch and the annihilation of the engineer, commissioners, etc., etc.

In the improvement of either class of drains with pipe, the more serious mistakes that can be made will consist in the want of fall and depth, improper care in placing pipe and back filling, and the neglect of the engineer in properly overseeing the work as it progresses.

Each locality has its own peculiarities, and has to be studied carefully by the commissioners, engineer and parties interested before any final decisions are made.

The truthtfulness of the trite expression that "anything that is worthy of being done is worthy of being done well" has been demonstrated to our full satisfaction many times. It has become, as it were, an axiom or a motto on which our eyes should ever be focused, and that which fills the requirements for which it was created, with the least objections, for the greatest length of time, is the best, whether it is the paving of a high street or the draining of the swamp lands of Ohio.

Lecture by Professor Orton, State Geologist.

On Wednesday evening, as per programme, the members and a large number of visitors were highly entertained by Prof. Orton's lecture, entitled "Stored Power of the World," which he requested the society to kindly refrain from publishing. At its conclusion the following short discussion arose which has some points worthy of preservation.

Mr. Wickenden—Mr. President, if the Professor will kindly allow, I would like to ask a question which suggested itself to my mind as I listened to this very able effort, and that is, whether it will be possible in the Professor's opinion to restore the arid plains to a condition that shall conduce to man's comfort?

Prof. Orton—By artesian water.

Mr. Wickenden—By the spreading out of vegetation?

Prof. Orton—That all depends upon water, and that is the engineer's work to bring the water, and then the rest will come.

Mr. Bowen—Mr. Chairman, it occurs to me that discussions are a little out of order just now, but I do feel that it is due the Professor to tender him a vote of thanks.

Prof. Orton—Oh, no, gentlemen; I am one of you.

Mr. Bowen—I make that motion.

The motion was seconded.

The Chair—That vote will be one-sided. Those in favor will say aye.

The motion was carried unanimously.

The Chair—Are there any questions that any of you would like to ask the Professor?

Mr. Wickenden—Can we estimate the time since these wonderful forces were stored up?

Prof. Orton—The age of coal, for example?

Mr. Wickenden—Yes.

Prof. Orton—Not very well in periods of years. We know where it comes in in the geological scale, but whether it is ten million years or five million years or twenty million we cannot say. It is safe, however, for us to conclude it goes back a good while.

Mr. Wickenden—And petroleum?

Prof. Orton—The great deposits of petroleum are older than coal. The petroleum of the Caspian region comes from later rocks, probably, but our own Pennsylvania and Ohio oils lie far below the coal. The Trenton limestone is a mile below the coal.

Mr. Wickenden—Does England know, with any very great degree of accuracy, the extent of their coal field under the ocean?

Prof. Orton—No, sir; there is some possibility there. Some late operations have been made of extension over towards the German ocean that are quite hopeful. But digging coal several thousand feet under the

sea is quite expensive work. And then the temperature rises as you go down.

A Member—The electric mining machine?

Prof. Orton Yes, sir, that has great possibilities. I am sure that I have not done anything like justice to that side. Water power can be transmitted —water power turned into electricity and transmitted in that way. A great deal is being done now that is going to be a great advantage. The water power of Niagara is equal to all the steam engines in the world, but we are not able to get much out of it yet.

A Member—I suppose you are aware that an attempt is being made to utilize a part of it.

Prof. Orton—Yes, sir. Of course you have to stay on the shore to get the tides. There is power enough, it is only how to get it. Captain Ericsson said when he died the solar engine was a more perfect engine than the steam engine, but it would not be brought into use until fuel got scarce.

Mr Wickenden—These monks you spoke of as enriching their land —how do they do that?

Prof. Orton They keep quite a herd, and these garden tracts are growing rich, perhaps at some expense to the other tract. They have quite a large tract of garden, and it is the finest I ever saw. There are a number of acres in it.

Mr. Strawn Are they seeking to enrich their grounds by the utilization of such crops as feed largely upon the atmosphere? Did you notice that?

Prof Orton—No, I don t know as they have much of the philosophy of agriculture, but they have a good practice that they have imported principally from the old world.

A Member—Isn't that attributable to another matter? That they have a great deal of labor that is used there that is paid for by some one else?

Prof Orton—They do all their own work; not a dollar is paid outside. They spend all their time in that garden and the farm labor. All of their work is done by themselves.

A Member—How many are there of them?

Prof Orton Well the number is not large now, the number is rather an inconstant thing There are perhaps twenty, or thirty or forty of them. They have a large pile of buildings, but they have been in more prosperous times in the past.

A Member—Are there any contributions from the outside?

Prof Orton No, I think not. They are quite rich. They have noblemen from Europe—Italy and France, who have come over and left fortunes to them

A Member—It strikes me that that is the secret of the great richness of that soil. That they have a vast amount of labor there that is supported from the outside, and probably if the labor applied to that soil was paid for in the ordinary way it wouldn t pay

Prof Orton I don't believe in the system much. I object to any improper inferences being drawn from it also.

Improvement and Protection of Domestic Water Supplies.

BY J. B. STRAWN, C. E., SALEM.

In the main, the substance of this paper is an effort to fulfill a promise made to this society three years ago, which promise grew out of a discussion on the self-purification of running water in rivers and streams. At that time it was my purpose to go into an investigation of the pollution of our rivers and streams which were used or available for water supplies. Upon more mature reflection and consideration, the theme broadened and expanded until it took on new phases, form and conditions. New questions presented themselves for solution, or, at least, for like consideration. If it seemed desirable to make an examination of our rivers and streams, as regards their pollution, why not also make an examination of our lakes, ponds, springs and wells, used for domestic purposes? The facts as regard the pollution of a majority of our city water supplies seemed quite evident from an examination of the mass of testimony deduced from the thousands of analyses of our city water supplies. And so far as testimony has been collected concerning our domestic supplies furnished by the ordinary dug wells, scarcely more can be said in their favor. Having no difficulty in determining the fact that our domestic water supplies, both private and public, are, in large measure, contaminated, and dangerously so, the next step should be to seek a remedy, viz., to improve the supplies where they were polluted, or else abandon them. But to improve our domestic water supplies would scarcely be enough; the water, when improved, or made potable, should be protected, and kept so. Hence, our title takes the dual form—improvement and protection of our domestic water supplies.

Having stated the subject under consideration, it may not be out of place to define what is meant by a domestic water supply. The generally accepted definition would be: Water used for drinking, cooking and general culinary purposes.

No greater boon can be conferred upon a home, community or city than a bountiful supply of pure, wholesome water. To obtain such a supply is worthy the best efforts and highest aims of the engineer, the most refined analyses and examinations of the scientist, the broadest and most comprehensive views of the philanthropist, and the best judgment and wisdom of the statesman.

To protect such a supply and maintain it in its purity, requires the constant vigilance of the sanitarian. He must know every watershed, nay, he must know every square rod of the surface which contributes its share

towards our ideal water supply, lest it become a source of pollution and danger instead of a purifier and vitalizer to the water supply. Every lake, pond, river, stream, spring and well must be carefully and frequently observed, examined, guarded, protected in the fullest sense. Systematic examinations should be made at regular intervals of all our public water supplies. No single test should suffice for any water supply.

WELLS.

From an examination of our country, it is very manifest that wells must continue to be the principal sources of our rural domestic supplies, and when the locations are favorable and the wells are properly constructed they supply the best and purest waters it is possible to furnish. Doubtless the best wells so far found, for domestic purposes are the driven and the drilled wells. Could this system only be adopted, it would be a great improvement over the ordinary wells as now found and familiar to all.

There are very few wells of the olden type that will not readily admit surface drainage, and, in very many cases, vermin and small animals along with household waste. Where such wells are found there is danger. It is to be regretted that greater care and attention has not been paid in procuring and maintaining purer well water supplies. The manifest carelessness in this matter in many cases seems almost criminal.

Quite recently a portion of the city of Salem was visited with typhoid fever. The health officers' journal has the following entry: Number of families in which typhoid fever occurred, ten; number of cases, sixteen; number of deaths, four.

The physical surroundings in this neighborhood cast strong suspicion on the well water used by these families. The health officers procured samples of water from three of the wells where typhoid fever occurred, and one sample was taken from a public hydrant, and sent the four samples to Dr. McCresson, a noted analyst of water, and chemist of Philadelphia. A report of these analyses, with Dr. McCresson's comments, was published in the Annals of Hygiene, published by the State Board of Health of Pennsylvania. This report was re-published in both of the city daily papers. None of the samples, upon analysis, indicated a first quality for drinking purposes. Two of the samples were pronounced unsafe for drinking purposes. The worst sample was from the well on Mr. William Hiddleson's premises. Dr. McCresson pronounced the water absolutely unfit for drinking purposes. He said: "It contains urine. The microscope shows the presence of membrane from the intestinal canal and great numbers of ciliata. * * * "

Mr. Hiddleson's wife died of typhoid fever a short time previous to taking the sample of water from the well, which they had been using for ordinary culinary purposes and for drinking. I called upon Mr. Hiddleson to gather what facts I could concerning his water supply. His own words were: "I think they have made a mistake; they must have got the samples of water changed somehow. I believe that my well furnishes as good water

as there can be found in the city." I asked, "Do you continue to use the water?" "Certainly we do." "How deep is your well?" "About twenty-eight feet; the foundations were sand, gravel and quicksand." "Just so. How far is your well from the old swamp?" "My well is about two hundred feet from what once was a swamp, and it ought to be all right at that distance."

Several years ago a small swamp, possibly less than an acre in area, existed in this part of the city, and is in the recent fever district. This district has, from time to time, been more or less afflicted with typhoid fever. Before the swamp was drained, two, if not three deaths occurred in a family living directly on the east side of this little swamp. In hot weather the stagnant little pool became very foul and caused complaint to be made by the few citizens then living in this vicinity. An examination of the swamp showed that a large amount of filth had been hauled and dumped there—several dead dogs and other animals with night soil and general garbage. I gave levels for a drain to carry off the surface water, which was put in by the citizens of this neighborhood. After the draining off of the swamp, the filth contained in the bottom was covered with soil. This drain passed within about fifty feet of where Mr. Hiddleson's well was afterwards put down. The well, being lower than the drain, which was open joint tile, and had but little fall, readily received a portion of the drainage of the swamp, which probably is responsible for the quality of water in Mr. Hiddleson's well. The death of a wife, and right upon this a report from an eminent authority on sanitary matters, ought to be sufficient to condemn a source of supply which pointed directly to the cause of sickness and death; but no; Mr. Hiddleson "thinks there was a mistake. It was some other water, not mine" which proved to be "absolutely unfit for drinking purposes." Mr. Hiddleson is a good, honest, much respected citizen, and has the sympathy of his neighborhood in the affliction he has suffered.

I have dwelt somewhat lengthily upon this case, for the reason that it is a fair representation of what exists in hundreds of other places. The problem for solution here is, How can such cases be reached? According to all sanitary rules for judging, here is a family, possibly more, who are exposed to diseased germs contained in the domestic water supply.

The city board of health, in such cases, have the power conferred upon them by existing laws for closing this well, but up to the time of my last visit they had not exercised this power. Another analysis is to be made of the water from this well.

If a careful and intelligent sanitary survey of this single little district had been timely made, and proper restrictions and prohibitions had been rigorously enforced, the probabilities are that four valuable lives might have been saved, and twelve other cases averted—to say nothing of the evil effects entailed by typhoid fever upon the victims and the nervous strain and exposure of the nurses and attendants upon the sick.

Statistics show that thirty thousand people die of typhoid fever annually in the United States. It is probably true that more than sixty thousand die annually of other diseases which may be traced to the effects of polluted water. At this time just what per cent. of the thirty thousand deaths from typhoid fever should be charged to the account of contaminated water supplies cannot be positively stated.

If we may be permitted to take the city of Vienna as a fair example of what may be accomplished by changing from the sewage polluted waters of the Danube to spring waters, the solution may seem comparatively easy. I here quote from the report of the Committee on Pollution of Water Supplies, appointed by the American Public Health Association, in 1888. The report says: "Vienna from 1851 to 1874 was supplied by well water of an impure character, in addition to a systematized supply from the Danube river. During this period of twenty-three years the death rate from typhoid fever ranged from one hundred to three hundred and forty, annually, in every one hundred thousand of the population. In 1874 a spring water was introduced, and the death rate from typhoid fever immediately fell to fifty in one hundred thousand. Since then, by the disuse of well water, and the extension of the new supply, the rate for the past three years has fallen to eleven in one hundred thousand, and inasmuch as the sewerage system was in existence during the period of high death rate, 1851 to 1874, the fall since 1874 is necessarily referred to the use of a water free from sewage. The fall in typhoid rate experienced an interruption in 1877 when owing to the freezing of some of the sources of the spring supply, the water of the Danube had to be pumped into certain of the supply mains, and it is of importance to observe that the sections of the city which were chiefly affected by typhoid epidemic were those in which the Danube river water was distributed."

The above showing is probably the most remarkable instance on a large scale that we have recorded unless we take London in 1853-4, at the time of the great cholera epidemic, where, as one writer puts it, "a gigantic experiment was undesignedly made on half a million human beings in London. It so happened that a certain district of the city was supplied with water by two rival companies, the water mains running side by side, some houses taking from one and some from the other. One of the companies drew its water from high up the Thames, where it was of comparative excellence, the other drew its water from low down the river, where it was profusely contaminated with town drainage and sewage. Among this population there were more than four thousand deaths from cholera. A careful inquiry from house to house was made, the result was as follows: In the houses taking water from high up the river the mortality per one thousand of the population was thirty-seven; in the houses taking water from low down the river, where contaminated by town drainage, the mortality was one hundred and thirty per one thousand of population, the death rate from cholera in the latter case being three and one-half times greater than in the former."

Returning to Vienna, should we institute a comparison of their death rate from typhoid, it would be far greater by reason of their change from sewage contaminated river water to pure spring water, as the figures stand three hundred and forty in one hundred thousand being the highest rate between 1851 and 1874, as against eleven in 1886-87-88, showing pretty conclusively that ninety-nine and seven-tenths per cent. of the typhoid may fairly be charged up to a contaminated water supply.

The great cities in Europe are not exceptions by any means to the rule. A careful comparison of the statistics and tables of mortality kept by the health departments of our American cities will show that our typhoid death death rate is wonderfully influenced by the character of the water supply. Invariably where other conditions are similar, we shall find the typhoid rate rising when the water is contaminated by drainage and sewage. I mean where the *domestic* water supply is polluted by sewage; and with a pure water supply typhoid fever is rarely known. An illustration on a small scale comes to view in the village of Leetonia, Ohio. For several years prior to the introduction of the public supply of spring water for the village, in 1889, there had been a number of cases of typhoid fever and several deaths, annually. Since 1889 I fail to find a case of typhoid fever reported by any of the physicians of that town where the public water has been used. Said one of the doctors, "The town is alarmingly healthy." New Orleans, contrary to what might be expected from a large city, with its location and physical surroundings, has an unusually low typhoid death rate. Since the city has not, and never had, any sewerage system, this condition of health must be sought for from some other source. New Orleans uses rain water, stored in cisterns built above ground, for drinking purposes, and here lies the secret of their excellent health. These citations might be largely multiplied, but it is not necessary; possibly enough has been produced to show that the sewage contaminated water supplies, cause almost all of the typhoid fever, and cause several other diseases which are closely allied to typhoid; also a large share of the zymotic diseases may fairly be charged to polluted water supplies.

I will not dwell longer upon this part of our subject. Sufficient has been shown from statistics to suggest to every thinking mind the need of improving our domestic water supplies.

Numerous analyses have been made of our river waters; very few, save those above our large river towns and cities, have made a favorable showing, and, from the very nature of things, i. e., the vast influx of population, added to our own increase,—the utilization of our rivers for conveyors of all of our city sewage, filth and garbage, the crowding of our population into our cities, towns and villages, the increased facilities for removing the sewage and other filth from our cities, directly into our lakes and rivers and larger streams by water carriage—all combine to produce impurities to such an extent as to render our river supplies in the near future wholly unfit for domestic uses.

The question of water supply is all important. We must either prevent the pollution of our rivers and streams used for water supply, or water must be obtained from other sources. Can the first be accomplished? Can we prevent the pollution of the water forming our domestic supplies? I think pollution may be prevented in very many cases, if not in all, and the sooner this can be done the better it will be for us. The committee was composed of five noted experts and doctors in sanitary matters, appointed by the American Public Health Association (and already mentioned), to report on the pollution of water supplies. I shall take the liberty to make one more extract from the report. The committee says: "That for protective purposes the knowledge that sewage enters the water is all that seems to be required, because where there is sewage there is danger of typhoid infection. Your committee desires to give special emphasis to the last stated clause, because it believes that the endemicity of typhoid fever in our cities is in great part, due to the sewage in the water supply."

There can be little doubt but that the purification and protection of our public and private water supplies from pollution is one of the most important measures for the prevention of disease. All of our domestic water supplies, whether public or private, should, upon examination, show, beyond a doubt, that the water is safe and wholesome. No standard short of this should be tolerated or even permitted to be used.

To accomplish this end, it will be necessary to exercise the greatest care in order to thoroughly know the watersheds upon which the rains and snow fall, which, though pure before coming in contact with the impurities found in, on and above the earth, may, before they reach the thirsty toiler or the domestic household, be charged with disease germs, or otherwise polluted to such an extent as to render them dangerous and, hence, unfit for a domestic supply. To this end every stream, river and tributary should be systematically and efficiently watched over, that no matters of a polluting nature may enter the water either directly or indirectly. More thorough examination of our domestic waters should be made. These examinations should not only be by the chemist, as has been the almost universal custom, but it should include the biological examination also. Our waters should be carefully studied. Yes, their history—natural history, if you please, should claim the attention of our State Board of Health and sanitarians, in order to know more fully their true character.

It is very gratifying to know that within the past few years the determination of the purity of public water supply has been receiving more careful attention than formerly, through the various methods of examination and experiments which have been made by scientists, both in Europe and in America, with a view of determining how best to provide a supply of potable water. Dr. Thomas G. Lee, one of the chemists to report on water analysis for the State Board of Health for Connecticut, says: "There is no practical method yet known by which the absolute determination of the wholesomeness of any given water can be definitely stated. Hitherto the

question of whether a given water is pure or not, has rested chiefly with the chemist, but now it is possible to secure additional testimony regarding the wholesomeness of water by means of the biological examination." The source of greatest danger in a water supply is from the entrance of sewage, as the most virulent pathogenic bacteria are found in connection with human excreta and the waste product of animals. Contamination with swamp water, which is saturated with decaying vegetable material, is probably the source of other noxious forms.

IMPROVEMENT.

Many of our public water supplies, especially our river supplies, may be greatly improved by sedimentation, as practiced on the large scale at New Orleans, St. Louis, and in a few other of our inland cities upon the large rivers.

Filtration, both natural and artificial, improves many of our waters. There are upon the market some most excellent devices for filtering water. Among these may be mentioned the National filter, which is used in a large number of cities and in various manufacturing establishments requiring a clear water. The American Filter Company has a large number of their filters in use in the West and Southwest; the Hyatt filter, which has been in successful operation for several years, is largely used; the Pasteurs filter is extensively used for filtering drinking water; a new filter, the Halliday High Pressure, recently noticed in Fire and Water, certainly possesses merits; the Standard Filter Company; the U. S. Water Purifying Company; the Oliphant system of filtration; some others deserving mention could be named, but necessarily must be omitted. The above filters are all good, if properly handled and intelligently operated; otherwise they may become a detriment and a nuisance, so far as improving the quality of the water. It is no uncommon occurrence for filtered water to show more dangerous impurities than the same water before filtering. The filters are allowed to become foul for want of flushing or other resorts for cleaning them, and the filter becomes a germinating bed for bacteria and other micro organisms.

Precipitation has been extensively carried on at New Orleans by Col. L. H. Gardner, superintendent New Orleans water works, and at St. Louis under Col. Gardner's supervision. "Mr. Gardner has been experimenting on the large scale with solutions of iron to hasten sedimentation in reservoirs and settling basins. Iron as a precipitating or filtering agent has been used in various forms and to a considerable extent on the large scale as a water purifier since Medlock, in 1857, patented a process in which water was treated by contact with metallic iron. The Anderson process is said to be in successful operation at Antwerp, Ostend, Paris and Vienna. The water in this process is first partially sedimented and then forced through a revolving purifier, consisting essentially of a wrought iron cylinder, mounted on hollow trunnions, which serve for inlet and outlet pipes. Curved legs, running lengthwise of the cylinder on its inner surface, scoops up and showers down

...t to obtain a suitable supply, will be an inducement to resort to artesian ...e borings of cast iron through the current of water. By the combined ac...n of the cylinder and the water current, every portion of water is brought ...o contact with the iron, the particles of which are kept bright by friction ...ainst each other and the side of the cylinder. After this the water is fil...red through beds of sand to remove excess of iron. The results claimed ...e that the organic matter is altered in its chemical nature, and the albu...inoid ammonia lesssened from one-fourth to one-half of its original amount, ...at the water is softer, and that the microscopic life of the water is, to a ...rge extent, destroyed or removed. At Antwerp, 2,000,000 gallons of water ...e treated daily, the results being quite satisfactory. Mr. Gardner has ...ggested the introduction of a solution of iron in the precise quantity need...d for the desired purpose. His experiments on Mississippi water at New ...leans gave satisfactory results to Prof. Chandler, of New York, and other ...emists. Later he treated a body of 13 000,000 gallons in the St. Louis set...ng basin, which met with favorable reports from the analysts. The action ... chemical, not mechanical. Mississippi water at New Orleans can be thus ...rified by a rest of eight hours in the reservoir, at an expense of one cent ...r every thousand gallons.

"In view of our knowledge of the conditions needful to a perfect nat...al filtration, it is impossible to allow that artificial means, operating afte... nature's methods, will ever produce as pure a supply as can be procured in ... suitable locality by digging a hole in the ground. In fact, artificial filtra...on amounts to little more than the mechanical separation of water from its ...spended particles, while the essential of natural filtration is the thorough ...trification of the albuminoids of the water. Some most interesting exper...ents are now in progress at Lawrence, Mass., which sustain the above."

Having called attention to a few of the methods now in use for improv...g our water supply, I still realize the difficulty there will be in meeting ...e wants of some of our large cities. Rochester, N. Y., has been struggling ...th the problem for a considerable time. Pittsburg, Allegheny also, which ...s just asked for a large appropriation to put down deep wells for the pur...se of securing a better domestic supply, and many smaller inland cities are ...ady to do likewise. This method, probably, will be largely resorted to in ...e near future for obtaining a potable water. A better knowledge of geol...y, mineralogy, physical geography and climatology will be assistful in the ...termination of some of the questions involved in procuring artesian waters.

The past year has marked greater progress in procuring artesian water ...an any former year in the history of public water supply. Notably so has ...is been the case in some of our Western States and Territories, single wells ...oducing several millions of gallons per day, so that great irrigation schemes ...e now being constructed to be supplied by artesian water. By reason of ...e whole face of the older part of our country being more or less settled, and ...e natural drainage of every valley bringing its sewage and waste from ...anufactures into our flowing streams, thus making it more and more diffi-

s for a supply, or to go far away for a purer supply than can be procured from the rivers and streams which traverse the face of our country. Paris, France, Brooklyn, Long Island, Memphis, Tenn., all have the best of water, and that "within one hundred yards of their domestic hearths." They went down into the earth, and forthwith there flowed fountains of living water.

"To permit the citizen to enjoy life, which, according to the constitution of the United States, is his right, the most stringent laws should be enacted and enforced to preserve the purity of our domestic water supply."

The sewage from our cities, villages, towns and public institutions, or from whatever source should be purified by precipitation, filtration, irrigation or by electricity, or by some other process before its water is delivered into the natural water course. "To protect the citizen and stamp out typhoid fever, it should be made the duty of every medical man who attends a case of fever to see that the excreta are disinfected before being consigned to the cesspool or sewer." The notable case of Plymouth, Pa., a city of 8,000 people, had 1,200 cases of typhoid fever and 130 deaths, as the result of infected water, caused by one fever patient, the water passing through three reservoirs on its way to accomplish its deadly mission.

Says an eminent authority, speaking on this subject: "So far as our knowledge goes, sewage would be deprived of that which, under ordinary conditions, constitute its only dangerous element, were this system of bedroom disinfection efficiently practiced."

A report to the American Public Health Association says: "Local authorities, such as water companies and boards, citizens' committees, health boards, and commissioners, should exercise a jealous guard over the public water supply; but, in many instances, these would be powerless without the intervention and co-operation of the authorities of the State. Massachusetts, Illinois and Minnesota have already taken steps in this direction. In Massachusetts the State Board of Health is invested with the general supervision of the water supplies. No sewage, drainage, excrement or other refuse or polluting matter of such kind or amount as, either by itself or in connection with other matter, will corrupt or impair the purity of a water used for domestic purposes, is permitted to be delivered into a water course or any of its feeders within twenty miles above the point where a water supply is taken. Upon the application of a city, village or town to the supreme court, alleging the pollution of its water supply in violation of law, an injunction may be issued, or the polluting substances required to be so cleansed or purified that they shall no longer be deleterious. The board is required to examine the waters from time to time to see whether they are adapted for use as domestic water supplies. The approval of the State Board of Health is a legal requirement to the consideration by the legislature of any application for authority to introduce any system of water supply or sewerage. The board has large powers and wisely-conferred. Finally, and very materially, the board is provided with funds to sustain the corps of engineers, chemists, specialists and inspectors, whose labors are needful to the proper performance of its duties.

I will here give the amounts expended by the Massachusetts Board of Health, which is found in Public Document No. 68, which shows that $44,854.95 was paid out under the direction of the board for the year ending September 30, 1889, while our great State of Ohio, which has a greater population, and in area more than four times that of Massachusetts, expended about one-tenth as much for the public health department, or, in exact figures, $4,576.16, as against $44,854.76 by the Massachusetts board. Massachusetts is an older State than Ohio, hence has seen the imperative necessity of taking a broader view than we have of the health problem. I believe that Ohio could very wisely and profitably expend more than Massachusetts did in 1889, if the necessary appropriation could be placed at their command, and the people of the State would be better off in dollars and cents by such wise expenditure.

In all civilized countries, $1,000 is counted as the money representation of a human life. Suppose that in Ohio, by taking the same precautions in guarding the public health that Massachusetts has done, and by so doing fifty deaths were prevented thereby This alone would represent $50,000, with no allowance for the unavoidable expenses attending sickness and death. It is very evident that an appropriation of $5,000 a year is quite insufficient to meet the requirements of our State Board of Health. They could and would do a grand work for the State if the necessary funds were appropriated and their authority broadened. This step should be taken now, before our sources of domestic supplies are all polluted. Let our rivers and their tributaries be protected from sewage or other forms of pollution now, and not wait until hundreds of valuable lives shall be sacrificed in consequence of a penny-wise policy.

There are in the small area comprising the State of Massachusetts one hundred and twenty-three sources of public water supply, and over two hundred samples of water are examined chemically and biologically every month from rivers, ponds and other sources that may be utilized in the future. Experiments are also in progress on methods of sewerage disposal, which will add to our knowledge of the results which may be obtained in that direction. Probably no State or country has gone to work with equal intelligence and zeal and philanthropy as has Massachusetts. The State is doing a great work, the results of which will be of incalculable benefit to the civilized world. Their wise laws already in force,—the experiment station at Lawrence, with a full corps of able specialists, whose labors have already given promise of the solution of the sewage problem, which may prove no less valuable than did those of Dr. Jenner in the discovery of the value of inoculation for the prevention of smallpox.

"With the aid of the State, the local authorities, in their efforts to obtain and preserve a wholesome water supply, would experience no difficulties that could not be overcome by the expenditure of the necessary funds The twenty-mile limit will, in time, be blotted out in Massachusetts, and the waters of the State will be sharply divided into those which may be used for

ater supplies for domestic uses, and those which carry off the waste waters. The water supply and the sewerage systems of the State and of the country should be as distinct as those of every household, and the sooner this is accomplished the sooner will the rate of sickness and death be decreased among our people."

The report of the committee before quoted from concludes by submitting the following resolution:

Resolved, That it is the well-considered belief of this Association that it is an imperative necessity, especially in the more populous States, that State legislatures should give their boards of health that financial support which would enable them to act intelligently on all questions pertaining to public water supplies, investing them, at the same time, with the supervision of the said supplies, and with power to preserve the waters from contamination by sewage or other injurious matters.

[Signed] CHARLES SMART,
S. W. ABBOTT,
G. C. ASHMUN,
W. W. DANIELS,
EDWARD PLAYTER.

In this connection I will briefly notice some points brought out by Governor Abbott in his late message to the legislature of New Jersey. In speaking of the public water supply to cities and towns, he says: "It is of far-reaching interest and importance to every center of population, present and prospective. It is the duty of the State to act in this department as the guardian of the interests of all of its citizens. The waters of the State are a portion of its domain, held by it as a trustee for the use of the public." A report, presented to The New Jersey Sanitary Commission, December, 1890, speaks in highest terms of the action taken by the commonwealth of Massachusetts in the efforts put forth to save the water supplies from pollution. Ohio can never do this work so carefully and effectually as now. Every year that elapses will see the problem of protecting our water supplies surrounded with new complications, which will tend to make the solution more difficult and more expensive. The State owns the streams and rivers within its borders, and these are, in large measure, to be drawn upon for the domestic supplies of our cities and towns. Individual enterprises and corporations are making a convenience of these once fair streams, to carry off their foul refuse and deposits, to mingle in the waters to be used for drinking purposes by those located next below, and these, in turn, do likewise to their neighboring towns below. England and Germany are now discussing similar measures. The revelations of the microscope and the labaratory of the chemist have done much to awaken thought and interest in these researches, but the work is only begun. It is the writer's earnest hope that some wise measures may be adopted by our State legislature which shall prevent the willful and indiscriminate pollution of our domestic water supplies.

Brick and Brick Pavement for City Streets.

BY R. D. SHIFLEY.

Mr. President and Gentlemen of the Convention

It is the object of this paper to give in as terse a manner as possible the method of paving streets in Bucyrus and the results of our observations and experiments.

The street is excavated to the exact shape of crown of street when finished. All irregularities are taken out, so as to produce an equal settlement when rolled. In embankment the dirt is put on in layers about ten inches thick, and rolled with a ten-ton steam road roller. The earth put in the embankment should contain no vegetable mold or perishable material of any kind.

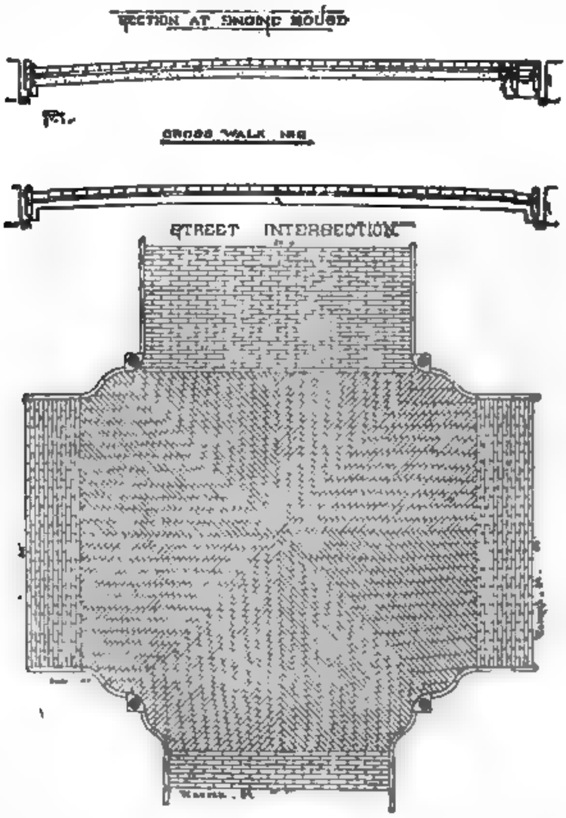
Too much stress cannot be laid upon the necessity of thoroughly rolling the sub-grade in both cuts and fills. To insure thorough rolling, I would recommend that the city own the roller and employ a man to run it and charge the contractor per square yard for all street rolled. After excavations, embankments and rolling sub-grade have been completed, common drain tile are put back of and thirty-two inches below top of curb. It is necessary to put gravel or sand over the tile, so the water will readily find its way to them.

The curbing is set on and backed by six inches of sand. Curbing should not be less than twenty inches deep, or it will fall over into the street during the process of construction. Crushed, unscreened, sand or limestone is next put on the street, of a sufficient depth to be six inches deep after being thoroughly rolled with a roller weighing not less than ten tons. If there be not sufficient screenings mixed with the stone, which is often the case with limestone, it will be necessary to throw over the surface of the stone, before being rolled, a layer of fine gravel. The cracks must all be filled, or the sand on which the brick are laid will run down through, causing the brick to settle. This foundation, if properly constructed and thoroughly rolled, is perfectly solid and made at much less cost than a concrete foundation.

There is next thrown over the surface of the stone two inches of fine washed sand. This is looped off to the exact shape of the crown of the street. On this sand the brick are laid. The brick are laid in parallel courses across and at right angles to the street, except at the intersections of streets, where they are laid at an angle of 45° or in the shape of a letter V, so that a wagon, in going in any direction, will not run the length of the brick, causing a tendency to rock.

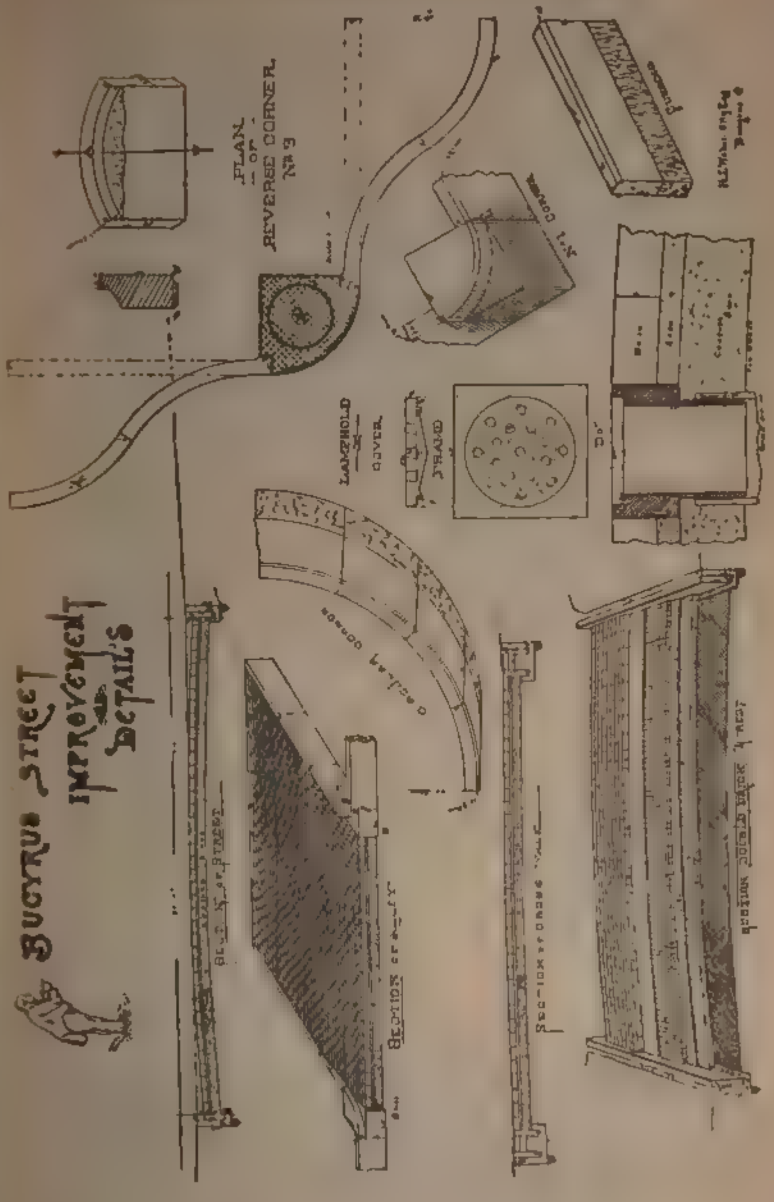
After the brick are laid, fine dried sand is thrown over the surface and broomed in. It is best if there be enough sand to nearly fill the spaces, so that when the pitch is poured on it will fill the space at the top of the brick.

Before tarring, the brick are rolled with a common road roller, weighing from six to eight tons. It should not weigh less than six tons, or it will not sufficiently settle the brick. If it weighs too much on the first rolling, it will break the brick. It is a good plan to roll it with a six-ton roller the first



time and then on the second and third rolling increase the load to eight or ten tons. After the street is rolled, it is a good idea to flood down the sand, especially so if the sand is wet when rolled, as it does not settle if wet.

The next operation is tarring. The tar is melted in a large iron kettle. This kettle is on wheels, so as to be easily moved from place to place as the tarring progresses. The tar is heated to about 300° Fahrenheit. It is run out of the tank into cans or buckets made for the purpose. As it is poured on it is broomed into the spaces with a broom made of steel wire splints. Sand is thrown on the surface while the tar is yet soft. This forms a kind


BUCYRUS STREET IMPROVEMENT DETAILS
PLAN
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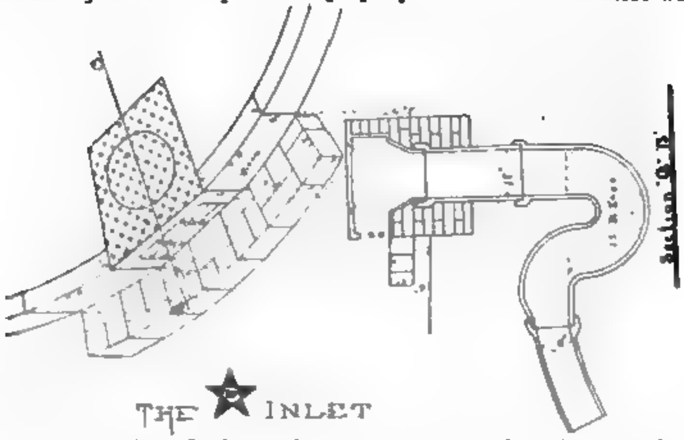
REVERSE CORNER
No 3

ncrete. In case a street is not tarred, the sand should be swept and . flooded into the spaces. I would recommend that a street be con cted without tar. Tar, after repeated freezing and thawing, loses its lities as a cement. A street is much easier repaired if not tarred. It is ll known, also, that water will not penetrate the spaces of the brick so as soften the foundation if the spaces are well filled with sand.

The making of paving brick for streets has become a profession in itself. he best paving brick I have yet seen are made of either pure shale, or mixed rith about 20 per cent. of common yellow clay. The brick should be thoroughly vitrified or amalgamated throughout, so as to form a homogeneous mass. The brick must not, however, be burned too hard, as they then become brittle. The brick made by the Bucyrus Brick and Terra Cotta Company are the best when burned to a dark cherry red. It is my opinion that a brick or block should be in size about eight inches long, four inches deep, and two and one-half inches thick. In this size a thoroughly vitrified brick can be made. If you increase the size, the brick cannot be burned hard enough in the center, or, if burned hard enough in the center, is too hard on the surface. There are brick being made with a salt glaze on the surface; I cannot conceive why a brick should be glazed, unless it is intended to deceive the engineer, by covering the flaws and cracks, and also to make a soft brick appear hard.

I have brought for your examination some samples of brick made by the Bucyrus Brick and Terra Cotta Company, which I consider as good as any that I have yet seen. A pavement properly constructed with these will last



as long as granite. In improving our streets, we have been putting in a drop called the Star Inlet, which we consider an improvement on the old cesspool catch basin. I have never yet met an engineer that could explain to my satisfaction the reason why the old catch basin was built so as to hold in deposit filth that would otherwise find its way to the outlet of the sewer

Substructure for Bridges.

BY W. K. LIGGETT, C. E., COLUMBUS.

It is unnecessary to recount the various stages the art of bridge building has passed through, from the rough hewn log extending across some mountain gorge, to those huge iron girders of which the present day is so justly proud. Archimedes is credited with saying that he could lift the world had he only something on which to rest his levers. Engineers of the present day not only have to design great levers to carry enormous loads, but are required to furnish the fulcra as well, for bridges are neither more nor less than levers resting on piers or substructure, which act as fulcra, and to which the loads are transmitted. It is of these foundations that I wish to speak, for a proper substructure is just as essential to the life and usefulness of a bridge as it was necessary for Archimedes' lever.

In building substructure, such material is generally utilized as can be readily procured that will be inexpensive, and, at the same time, will make a rigid foundation. Wood and stone, with cement, have formerly answered these requirements, and lately iron has come to be used in the same way.

The Latins used wood piling as substructure for their draw bridges before they had intrenched themselves so well on Roman soil as to be free from the attacks of the barbarians by night. Later these wooden structures were replaced by permanent stone arches. Cæsar, in his famous bridge across the Rhine, which he constructed in eleven days, made the substructure of wood bents, framed much as we erect false work for bridges now. But each bent was protected against drift by wooden staves or piling driven on the up-stream side. Indeed, the great sustaining power of piling, the security they afford against a scouring current, and the ease and rapidity with which they can be erected, have made this kind of substructure very popular, especially in soft ground and over wide and sluggish streams. It is well known that if protected from the elements, and especially the air, timber will last many years, but if allowed to be wet and dry alternately, will very soon decay. Consequently, wood piling, when left partially above water, is very short lived, and should only be used for temporary structures where saving in first cost or time of erection is of more consequence than the permanency of the structure.

Stone structures, when properly erected with good materials, usually fulfill every condition of permanency, and the merits of this substance are so well known and so well appreciated that it is useless to say anything in its favor. But stone masonry, however good the workmanship and materials may be, is very treacherous when built on an insecure foundation, and even when the soil on which it is built seems at first to be rigid and firm, the abrasions of the current often undermine it, and its own excessive weight

hastens its destruction. It is here that the merits of wood enable it to be brought to the rescue, for on soft ground it is the usual practice to use a grillage of timbers in the bottom of the trench, or, better still, to build the grillage on top of wood piling, driven well into the earth, the whole being surrounded with rubble or concrete, the details of both methods being so well known and so universally practiced as to need but a passing glance. Where stone is expensive or poor in quality, hard burned brick, laid in good cement mortar, is often very successfully used as a substitute. The substructure for the Firth of Tay bridge, in Scotland, was built of this material, the several piers being started on the shore, enclosed in iron caissons. It was then carried into place by pontoons, lowered by means of hydraulic jacks, and sunk to proper depths by means of sand pumps. After being firmly fixed in place, the interior of the cylinders was filled with concrete and the brickwork carried up above high water mark.

The difficulties and expense often incurred in securing a good stone foundation, and the temporary character of wooden structures, together with the improved methods in the manufacture of iron, and its decreasing cost, have led to the latter material being more and more employed for this purpose. The theories advanced by those who advocate the use of cast iron for substructure seem to be about as follows: All piers, except those designed to resist the unbalanced thrust of an arch or a bank of earth or water, have their dead loads in a direct vertical line. The moving load, except that due to wind pressure, also always acts vertically, and the resulting load on any pier being the sum of the live and dead loads, can be borne by a structure having the majority of its members in a state of compression. Now, cast iron is admirably fitted for transmitting compressive strains and, moreover, by the process of manufacture, it becomes coated with an external skin or layer of silicate of iron, formed by the union of the molten metalwith the sand of the mould, which effectually prevents corrosion, even in moist earth or water. Iron substructure may be roughly divided into tubular piers or caissons and iron columns or piling.

Tubular piers consist essentially of an iron shell or caisson, enclosing a brick, stone or cement column. The shell is usually made of tank iron from one-eighth to three-eighths of an inch thick, rivetted up into a tube from sixteen inches to as many feet in diameter, and of a length to reach above high water, and often quite to the bridge shoe which it supports. These tubes are usually put up in pairs, with one tube under each truss of the bridge. They are connected and braced together by struts and diagonal rods to counteract wind pressure. The foot of the pier is usually placed on or over wood piling, and, after being leveled and adjusted to the proper heighth and position, the whole is filled full of rubble mortar, and the bridge shoe placed directly on top. It is also usual to protect the outside of the foot of the piers with riprap to prevent wash and make the piers more stable. The outside of the piers should also be kept well painted in order to protect against corrosion. These piers are often worked out with many variations in the de-

tails, and are often sunk many feet below low water by excavating from the interior. Often this excavation is done by means of sand pumps, and the piers are sunk without removing the water from the interior. But when the ground must be dug by manual labor, either divers are employed or the water is forced out by means of compressed air. In this way the piers of the St. Louis bridge were carried down one hundred and ten feet below the surface of the water. In fact, to the caisson formed by the tubular pier, with many a variation in details, do we owe some of our finest bridges, and it is safe to say that for difficult foundations in deep water the iron caisson has come to stay.

Screw piling, I believe, was first introduced in England under patents to Alexander Mitchell and hence are known as Mitchell's screw piling. The pile or shaft was made either of wood or iron, cylindrical, or nearly so, in form. The screw blade fixed near the foot of the pile, was usually of cast iron, and seldom made more than a single turn. Its diameter was from eighteen inches to six feet, and its pitch from one-half to one-fourth its diameter.

Screw piling are forced into the earth by applying the power of men or animals to levers attached to the pile head and screwing the pile down into the earth. Piers made of Mitchell's screw piling were used for bridges on the Bombay & Boroda Railroad, and are described by Lieutenant Colonel Kennedy in the Civil Engineers and Architects' Journal for September, 1861. Each pier consisted of three hollow cast iron cylinders two feet six inches in external diameter, and the shell one inch thick. These cylinders were placed fourteen feet C. to C., and were made in sections nine feet long. These sections were connected by flanges and bolts. Above ground the flanges were external, and each joint is fastened by twelve one-inch bolts, while under ground the flanges are internal, and ten bolts are used. This diameter was adapted as the least which would enable a man to go inside to fasten the bolts. The lowest length formed a screw pile with a blade four feet six inches in diameter, by means of which the pillar was screwed from twenty to forty-five feet into the ground. The superstructure of these bridges is Warren girder trusses.

Screw piling has been used to some extent in this country for substructures, but I have been unable to secure any exact description of them. Another form of piling much used is the disc or hydraulic pile. They are usually hollow cast iron tubes, with a flat plate or disc at the foot of each, and are adapted for sandy soils. The piles are set up on end at the proper place and the disc is undermined by jets of water brought down through the hollow shaft, the pile being kept plumb and weighted so that it will sink as fast as the excavation is made, the loose sand almost immediately fills up the space above the disc, and so holds the pile quite firmly. Hydraulic piles may be sunk quite rapidly.

In the majority of cases an extraordinary depth penetrating in the ground has been found quite unnecessary, and the idea was conceived of

driving iron piling in the same manner and by the same means employed for wooden ones, and afterwards fastening to a plate bedded in the soil or on a layer of cement or grillage. The plate evidently performs the same office in making the pile stable that the blade does for the screw piling, or the disc for the hydraulic pile. This system of substructure is known, from its inventors, as the Gray-Abbott system of iron substructure. The following description is, for the most part, taken from the catalogue of the Iron Substructure Company, of this city, who own and control the patents for Ohio and adjoining States:

"The Gray-Abbott system of iron substructure consists essentially of cast iron piles, one end terminating in a cylindrical head and the other pointed to be driven into the earth until the tops are at the required level. They are surmounted by caps of various shapes and sizes, to accommodate the rest of the structure. The piles are usually made of an X or cross-shaped section from eight to eleven and one-half inches in diameter, and from eight to thirty feet long. T shaped or H shaped sections are used for special work. Where the structure to be carried is excessively heavy, or where the ground is very soft, a ground plate from eighteen inches to four feet square is slipped over the pile after driving, bedded into the earth and fastened to the pile by suitably-shaped keys which straddle the flange of the pile, and are driven home after everything is adjusted. Often the ground plate may be placed on a grillage of timber built under it, which will effectually prevent the pile from settling. In most cases, however, the ground is sufficiently firm to render the use of a ground plate unnecessary, and it is rarely used. The cap carries a cylindrical bell on its lower side, which loosely fits over the cylindrical pile head, and allows the cap to be raised, lowered or turned about to any desired angle. The cap being adjusted to the proper position, the space between the bell of the cap and the pile head is poured full of melted brimstone or lead, through holes left for the purpose in the top of the pile cap, the melted metal being kept from running out below by means of moist clay. The metal is also allowed to run over the top of the pile head so as to make a firm bearing all around for the cap. This virtually so fastens the cap that it becomes one solid piece with the pile, and for all practical purposes may be thus considered, for it cannot be moved without moving the filling of metal or breaking the cap. These iron piling are used in the same way and have all the advantages of wood piling, with the additional one of permanency, for the life of a cast iron pile is beyond limit. By the addition of struts and rods, the structure can be carried up to an indefinite heighth without decreasing its stability in the least. Piers are protected from ice and other drift by nose piling beams and other devices commonly employed for stones piers. Altogether, this system of piling has given most excellent satisfaction and surely merits extensive use."

What shall be the character of the substructures for our bridges, is a question that it would be impossible to treat completely or scientifically in the limits of this paper. The question depends so much upon the circum

stances connected with the particular structure in view, and the conditions are so various that no general treatment can be given. Besides, even the best informed and most thoroughly experienced men disagree radically on the subject, and, after all, in the present state of the science, much of our knowledge, is merely a matter of opinion.

Other things being equal, of course, the question of economy should have its due weight, where, as in the case of cast iron piles, the fact of their security and permanency is thoroughly established. Where stone is plentiful and one is sure of obtaining a firm foundation, of course we should not hesitate to adopt it. Brickwork, too, when properly put up, I do not think is fully appreciated by the profession. For temporary structures, one can often find no better or cheaper material than wood, used either in the shape or piling or trestle work. In very deep water, it has always been found necessary or convenient to use some sort of caisson, and where everything else has failed, the Gray-Abbott iron piling has stood and is standing the test.

Measure.

BY D. W. PAMPEL.

The word "Measure" implies a large and almost limitless scope of application. Measure, in some way or other, determines our comprehension of everything, and there is some scale, rule or standard by which everything is measured.

It is not intended in this paper to describe, or even mention more than a very few of the appliances, methods and instruments used in making measurements. The measurements made, and the few instruments used for the same by the draughtsman, the mechanic and the engineer, are those we wish to consider and compare.

The straight scale one foot long, of equal parts divided into tenths, hundredths, thousandths, and so on, or into inches, halves, quarters, eighths, sixteenths, thirty-seconds, sixty-fourths, and so on, will determine any distance, area, or volume of any solid, and the circle divided into degrees, minutes, seconds or decimals, will measure any angle. Armed with these two simple instruments, and others created by their aid, it is possible to produce any mechanical device or structure known to man or his inventive genius, or to solve any problem in geometry or astronomy.

The surveyor's and engineer's work consists largely of measurements, and these measurements are generally lengths or angles; the accuracy of his work will depend much upon the accuracy of the intruments he uses. To give a history of our standard measure of length would require much investigation, and then would only show that there is no absolute material standard, and that all standards, fixed by all nations and authorities, are only approximate, and not absolute. All scientific investigation goes to show that any standard of length adopted can only be arbitrary, for every method adopted to fix a standard has produced only an approximation. The best we can do is to take our arbitrary standard and preserve it as we find it. The yard, which is intended to be identical with the imperial yard of Great Britain, is the standard measure of length in the United States, adopted by Ohio and some of the other States, and probably now by all. We have a standard foot as well as a standard yard, and much more conveniently divided, both decimally and duodecimally, and use it as the unit of measure. It is the most convenient and comprehensive for all measurements and quantities, excepting land, and for that the chain and link, which expresses whole acres and fractions in one hundred-thousandth parts, is the most convenient and comprehensive measure. I have the same profound regard for the chain and link that I have for the foot and inch, or tenths and hundredths, and hope and believe that they will be immortal alike.

It has already been stated that any standard of measure adopted must

be arbitrary. So, if a certain length arbitrarily constitutes a yard, it is also fixed and agreed that one-third that arbitrary yard is a foot, that one-twelfth of that foot is an inch, and that seven and ninety-two hundredths of these inches, are one link, or one-hundredth of a chain; that sixteen and one-half of these feet are a rod; that sixty-six of these feet are a chain, and so on, so that whatever unit of measure is fixed and adopted as the standard all other units of lineal measure are established by it.

A comparison of the instruments in use for measuring length, such as the foot yard, leveling rod, rod, chain and steel tapes of all lengths, will show the degree of accuracy which has been attained by the many manufacturers of these instruments.

Through the kindness of Mr. Cummins, the auditor of Shelby county, I have brought with me the standard yard established by congress in 1836, and also adopted and established by the legislature of Ohio in 1846. This measure, as you can see, is of bronze, one-half inch thick by one and one-eighth inches wide, and three feet between raised ends. This space is divided into three feet, and one of the end feet is divided into inches. The graduations are coarse, and the bar is not straight, being curved edgewise. It has the appearance of having been made by a very ordinary mechanic, and presents no such features of skill, precision, care and workmanship as do instruments made by mathematical instrument makers at the present time. No name of manufacturer is on it. With this standard I compared four triangular scales, each one foot long, two of wood and two of metal, all marked "U. S. standard." The metallic scales are slightly longer and the wood scales are slightly shorter than the standard. None of these scales are graduated to a degree of fineness equal to the scales on transits or theodolites. A New York leveling rod was compared with this standard, and in three feet it was one-thirty-second of an inch too short. Steel lines were compared as follows A fifty-foot Chesterman line, a one hundred-foot James W. Queen & Co. line, one hundred-foot Justus Roe & Sons, and a three hundred-foot Heller & Brightly The Chesterman and Roe lines were practically identical in one hundred feet, the Queen line was one-eighth inch short, the three hundred-foot line was three hundred feet, but the first one hundred feet was one fourth inch too long and the second and third one hundred feet were each one-eighth of an inch too short. These comparisons were made at a temperature of sixty degrees Fahrenheit.

I also compared two new one hundred-foot Chesterman metallic tapes. One was three inches too long and the other was three inches too short. As a matter of course, no one relies on this kind of line where any degree of accuracy is required The old link chain is but little more reliable, owing to the many places it has to wear. Usually, the link chain has two small rings between each two of the long links and some have three, but if it has only two, there are six bearings or places to wear for each link of chain, excepting the two end links Then, in a chain of one hundred links, there are

six hundred places to wear, and if each wore one-one-hundredth of an inch —which would but little more than brighten the metal—yet it would make the chain about six inches too long. I don't know to what extent these old link chains may still be in use, but the time is certainly here when they should be sent to the garret with the old sickle and spinning wheel, once valuable necessities, but now totally useless, except as relics of their past employment.

Having compared the measures we use to determine length or distance, let us now compare the measurements we make with these instruments. The architect or engineer makes his drafts and designs for structural work to a convenient scale, showing the shapes of all parts of the work in plain sections. He marks the required dimensions on all the parts which are to compose the entire work. To construct the work designed is the mechanical part, and the degree of exactness with which the work is accomplished will depend upon the accuracy of measurements and the correct shaping of the parts. The skill of the mechanic in measuring and executing the shapes of all the different members of any structure will be determined by the degree of exactness required in the accomplishment of the work, whatever it may be.

The degree of care and accuracy in measuring and shaping the members of a wooden structure, such as a house or bridge, would not be sufficient for the same members if they were composed of iron or steel. The greater the degree of accuracy and perfection required in any construction, the greater will be the care required in measuring and shaping the different members, and the more delicate, sensitive and positive must be the measures and engines of construction; and with all these, any work of man will be only an approximation to perfection, whether it be to construct a bank of earth or an astronomic or a mathematical instrument.

In a conversation with a very fine machinist, in reference to the degree of exactness of the scales and measures and the construction of the parts of a machine, to the dimensions required, he made the remark that the touch of an experienced mechanic's fingers was a more delicate test of measure than the finest graduated scale, and gave, as an example, the fitting of a shaft in the hub of a wheel. When the hub was bored through to the dimension required, the shaft must be turned to the same dimension to make a complete fit. If the shaft was immeasurably larger than the hole, it would require too much force to drive it home and the equilibrium of the molecules would be disturbed, and the machine would be more liable to lose its adjustment, under various conditions of use, temperature and strain. If immeasurably too small, the parts could not be in equal contact, and therefore the same liability to lose its adjustment under the same conditions above mentioned. The delicate measure to reduce the shaft to the proper diameter is best accomplished by the use of a pair of calipers in the hands of a mechanic or artist. They are fixed to take in the required diameter, and as the operation approaches nearer and nearer completion, each time the cutting edge travels the required space on the revolving shaft, trying his measure until it

passes over the diameter, he notes the decreasing pressure at each succeeding trial, until that touch is felt which allows the points of the instrument to pass over the diameter, with that delicate sense of touch which he recognizes as the ultimate limit of exactness which will make the desired contact.

It may be remarked that, while all measurements only approximate the absolute dimensions, the errors will be in proportion to the magnitude of the work. An error of one link in the measurement of a mile would be considered a very near approximation to the true distance, in the measurement of ordinary lands, but an error of the same amount in the construction of a building or bridge would be considered gross carelessness.

The following table will illustrate the error in measurement of a few surveys which have been selected with reference only to the increasing areas:

No. Acres.	No. Sides.	Northings.	Southings.	Eastings.	Westings.
3.30	7	4.49	4.50	12.06	12.07
14.91	6	16.33	16.35	13.42	13.36
49.81	6	21.63	21.57	34.30	34.30
52.50	8	40.79	40.83	24.35	24.34
60.68	7	22.69	22.69	37.87	37.88
64.77	7	22.69	22.66	37.82	37.79
83.18	6	40.73	40.72	33.73	34.06
93.79	6	27.57	27.55	42.45	42.43
110.28	6	39.79	39.81	35.72	35.42
120.90	12	45.50	45.55	39.73	39.86
331.33	5	45.87	45.83	84.34	84.18
636.06	6	85.09	85.13	84.00	84.18

The above examples are, perhaps, an average of the degree of accuracy of my work. Some of these surveys were made several years ago, a part of them with an open-sight compass, and a part with a transit or theodolite. All the bearings were taken with the needle, and all the measurements made with a band chain, the bearings being read to quarter degrees, and the latitude and departure taken from a traverse table. It would seem that the bearings ought to be read to minutes, and the latitude and departure computed from the table of natural sines. While this would make the angles more accurate, the measurement of the distances could not be much improved without a system and appliances to reduce all distances to truly straight and horizontal measurements, which, for the survey of ordinary land, would be too tedious and require too much time to justify a nearer approximation of the true area.

Davies remarks, in his "Elements of Surveying," that: "It is the opin-

ion of some surveyors that when the error in latitude or departure exceeds one link for every five chains of the courses, the field notes should not be relied on. This," he says, "perhaps is a higher degree of accuracy than can be attained," but further remarks that the error should always be made considerably less than one link to a chain. It may be noticed that only half the examples given fall within the first limit.

The object in giving the above examples is to compare accuracy and methods in doing this kind of work now. It may be proper to add here that in this county (Shelby) no ferruginous substance nor any disturbance of the magnetic meridian has ever been discovered or reported.

In "Instructions to the Surveyors General of the Public Lands of the United States," of 1855, lines are to be measured by a two-pole chain of thirty-three feet in length, consisting of fifty links, and each link being seven inches and ninety-two hundredths of an inch long. On uniform and level ground, however, the four-pole chain may be used. The east and west section lines, except those terminating on the west boundary of the township, are to be within one hundred links of eighty chains in length, and the north and south boundaries of any section, except in the extreme west tier, are to be within one hundred links of equal length. "The meanders within each fractional section, or between any two meander posts, or of a pond or island in the interior of a section, must close within one chain and fifty links." The above seems to be the limit of error to be recognized in the measurement of public lands.

The instructions of 1881 to the United States deputy surveyors. require that the township lines, and also the sub-division lines, will usually be measured by a two-pole chain, thirty-three and three-hundredths feet in length, consisting of fifty links, and each link being seven inches and ninety-two-hundredths of an inch long. The four-pole chain must be sixty-six and six-hundredths feet. This is an impossibility; for one hundred links, each seven and ninety-two-hundredths inches long, is not sixty-six and six-hundredths feet. The meaning, evidently, is that in making calculations the length is to be regarded as only one chain.

Let us now look to the degree of accuracy we attain in the measurement of angles. These measurements, like those of length, are only approximate, and the degree of exactness attained will depend upon the accuracy of the instrument employed, and the care given to its use. For mechanical and engineering purposes generally, the circle of four to six inches in diameter graduated to read to minutes, is sufficient. For geodetic and astronomic work, where the greatest degree of perfection attainable is required, much larger circles are employed.

I will give a couple of examples illustrating the use and results of measurements, such as are most common in our practical, every-day work. Several years ago, when we were building our court house, I was called on to stake out the foundation. The exact point for the location of the center of the building was the first thing determined. Over this I set the transit, and

at about one hundred and fifty feet each way, north, south, east and west, set stakes, ninety degrees apart. Around each of these four stakes were planted three substantial fence posts, in the shape of an equilateral triangle, with sides about four feet, one being parallel with the side of the building facing it. On each side of the triangle formed by the posts, two strong fence boards were substantially nailed, after dressing the sides of the posts parallel with the sides of the triangle. The transit was then directed to one of these triangular monuments, on the center line for the building, and clamped with the zeros coinciding, and this point marked across the face of the board. The instrument was then turned ninety degrees to the right, and that monument marked in like manner, it was then turned to one hundred and eighty degrees, and the south monument was likewise marked, then turned to two hundred and seventy degrees, and the west monument marked the same as the others. When the instrument was turned on to three hundred and sixty degrees, it had made a complete revolution, and, as a matter of course, must strike the first mark. At each of these marks the edge of the board was sawed into about a quarter of an inch, to preserve the lines for all future measurements, until the grade line was reached and the neat work begun. These monuments served their purpose well, and were a ready, reliable and convenient reference for the contractors, builders, and anyone concerned. As remarked, the instrument has made a complete revolution, and is in the exact position it was when the measurement of the angles was begun. Now, if the instrument is in adjustment and graduations are equally spaced on the plates to revolve the telescope, the vertical wire must bisect the saw mark in the opposite monument. If the line of collimation be out of adjustment and the graduations equally spaced, no error would occur in measuring the angles as long as the same side of the telescope was kept above. These angles were measured a number of times on different parts of the plate, directing the telescope on the same monument, beginning at fifteen, thirty, forty-five, sixty degrees, etc., advancing by ninety degrees, also beginning with zero on each of the points and advancing by ninety degrees the entire circumference. In only a few of these measurements or observations did the spider's line bisect the saw cut, and in many of them it fell clear outside of the cut. My instrument is an old one, and, perhaps, does not come up to the standard of accuracy of the instruments manufactured within the last few years. However, this little inaccuracy could have nothing to do with the appearance or usefulness of a temple of justice, nor could it furnish a case where the scales of justice were not so delicately poised that it would not satisfy the most exacting.

Another example of the measurement of an angle was made as follows: The theodolite was set directly over a point seven hundred feet distant from another point on a horizontal line which was carefully measured. The height of the instrument was 4.460 feet, 34 minutes was turned off on the vertical arc. This is nearly equal to the angle between the focus and the two stadia wires of a telescope. The natural tangent of 34 minutes is

.009890, and for 700 feet, 6.923 feet. This 6.923 feet, plus 4.460 feet—the height of the instrument—equals 11.383 feet, which, if both the angle and the distance were perfectly measured, would be the reading of the rod. But instead of reading 11.383, it read only 11.314, a discrepancy of .069 of a foot on the rod, which would be equal to deficit of 7 feet on the horizontal measurement. This discrepancy cannot be due in any considerable degree to the horizontal measure, for it must have been true to within one-tenth of a foot, so the error must be chiefly due to both the inaccuracy of the observation and the graduations of the instrument. The error is evidently due more to the observation and imperfection of reading the vernier than to instrumental error. The condition of the atmosphere is also a fruitful source of error. But if all the conditions were absolute, the reading of a minute on a vernier whose radius is 3 inches, is a very difficult thing to do when we consider that one minute of arc on a 3-inch radius is a space of only $\frac{1}{1250}$ of an inch. If this space be bisected, we have a $\frac{1}{2}$ minute, which is $\frac{1}{2500}$ part of an inch, certainly the limit for reading such an instrument.

The angles of the primary triangles of the United States coast survey are measured with theodolites whose horizontal circles are twenty-four or thirty inches in diameter, and to eliminate, as much as possible, every source of error, from forty to sixty observations are made for each angle. With these precautions it has been found that the error of a primary triangle (where the sum of its three angles has been compared with one hundred and eighty degrees) has fallen within three seconds. The error of three seconds has been adopted as the highest admissible limit of error.

The statement is made that the Lick observatory, in California, locates its latitude to within one-tenth of a second. This would be within about one hundred feet of the true position. This is not a very large error in twenty-five thousand miles.

Until recently, the distance given from our earth to the sun was ninety-five million miles. Recent measurements and calculations give the distance, in round numbers, ninety-three million miles. This discrepancy, like the others, is owing to the fact that the measure of the base and angles is only approximate, and cannot be exact.

Mr. Varney, the chairman of the committee on land surveying, asked me to contribute to his committee the notes of some survey made by myself. The survey which I will now describe was intended for the report, but Mr Varney suggested, afterward, that it might as well be included in this paper on measurement.

The survey was made in Wyoming Territory, on July 21, 1889, and the notes are taken from my diary of that date. The work was executed without a chain, compass or transit. The writer was with a party of tourists from the States, accompanied by very intelligent ranchmen and herders of that neighborhood, in all about twenty persons. The object of the visitors was to see the mountains and whatever else they could, of interest, and that of the ranchmen was to look for more or better pasture fields for their herds.

They had all heard of a wonderful canon on the North Platte, though none of them had ever seen it. The canon is situated about forty or fifty miles north of Fort Steel, and between the mouths of the Medicine Bow and Sweet Water rivers. No one in the party knew whether these lands had ever been surveyed, but as the land is unfit for cultivation, it is not likely it has been surveyed into sections.

On Wednesday morning, with three wagons and four saddle horses, our party started from Carbon Station on the U. P. Railroad, and arrived at the canon on the next Saturday afternoon. We traveled about twenty miles each day. The trail was circuitous among the rocks and hills, and it was thought that our wagons were the only ones that had ever traversed that part of the country. The surface is very broken and rocky, and where there are no rocks nor strong alkali clay, sage brush and grease wood grow to about the height of wheat or oats, and, in some places, about as thick. The lower hills and basins are about four thousand to five thousand feet above the sea, and the higher ridges or plains are from seven thousand to eight thousand feet above the sea. From these higher plains, Loraine Peak to the east and Elk Mountain to the south, were often in sight with their tops covered with snow and to the westward, the red, rocky summits of the Seminole mountains could be seen.

We passed through Shirley's basin, which is comparatively level, is three thousand feet below the surrounding hills, and has an area of over three hundred square miles. Numerous springs of clear, cold water, but somewhat alkaline, gush out of the rocks around its edges, forming beautiful, clear rivulets, winding their way through the green, grassy plain, to finally lose themselves and sink in the dry sand. On our journey we found sparkling, clear, cold water gushing from the rocks at every ten or twelve miles. At these springs were always green grass plats in the desert, extending out until the water sunk into the sand. This region abounded in sage hens and antelope, which furnished our party an abundant supply of most delicious meat. When on some of the highest and level plains, in looking around the horizon, fifty antelopes might be seen at one time.

As we approached the channel of the Platte, and parallel with it, there were perpendicular walls of rock, one hundred feet or more high, each stratum as smooth and level as if the wall had been laid up for a building. The coping on the top, apparently as level as water, ornamented with stone as large as a house lying on top, some resting on a base of only a few square feet, and often on these again were lying other large rocks, which looked as if it would not require a very strong person to push the whole mass over the precipice. On the terrace below were scattered broken rocks in wild confusion, so close together that it was a difficult matter to find a passage to drive a wagon between them, many of them containing one hundred cubic yards. On top of these, again, would often lay large rock. This wild and grand confusion of rocks extends for miles along the Platte, with here and there a break in the walls where a canon has forced its way to the river. Down one

of these canons we wound our way to the river, which was about five hundred feet, perpendicular, below. Just as we were entering this gorge, the mouth of the great canon through which the river flows came in full view, up the river nearly a mile away. The appearance was that of a mountain ridge thrown across the river and broken in two. The crack appeared to be one hundred feet wide or more, and its dark line could be traced across the mountain until it passed beyond our line of sight. Out of the bottom of this crack and broken mountain flowed the river. Here was a magnificent sight, a mountain dam across the river broken square in two. We descended to the river, crossed to the west side, and followed it up to the mouth of the canon, where its walls were as perpendicular as those of a building. In the angle between the foot of the mountain and the edge of the river was a beautiful, level lawn of green grass, kept so by the near-flowing river and cooling noonday shade of the mountain. Here on this magnificent lawn we pitched our tents. Before night came on we had time to take a partial look at the canon; starting at the mouth we ascended along its edge; the entire surface was sandstone, with here and there a stunted fir or cedar growing out of the seams in the rock. The ascent was easy and delightful, like a great stairway with steps from six inches to one or two feet high, and from five to twenty feet wide. Before we arrived at the summit our march was cut off by a lateral fissure from the west. Here we stopped on a large table rock, twenty or thirty feet square, on the corner of the great canon and the fissure from the west. We cautiously advanced to the edge of the precipice; there was no limb, nor tree, nor rock, nor balustrade by which to hold, except the rock beneath our feet. Cautiously we peered over the edge, down into the deep, dark abyss between the two perpendicular walls, to the shining river below. The sensation was almost like that of an electric shock; here a single step forward would be into eternity. Carefully we drew back from the precipice and retraced our steps down the mountain to our tents on the beautiful lawn below, where a delicious supper of warm short-cake, fried antelope and young sage hens, with fat bacon and gravy, and strong coffee with plenty of sugar was soon served and partaken of with appetites characteristic of that pure mountain atmosphere. This was only a repetition of our meals during the journey. The evening was cool and delightful, although the day had been very warm. We filled our buckets with water from the river, and set them on the bank; by morning it was almost as cold as ice water. The next morning was Sunday, and we spent the whole day at the canon, traveling along its edge over the mountain, looking down its somber depths, and viewing this wild wonderland of hills and rocks. I wanted to know the depth of this royal gorge, this imperial fracture, but had no barometer, chain, compass or theodolite with which to measure it; I had a one-foot rule in my pocket, and with this measured and used a lariat for a chain, tent poles for sighting and leveling rods, and referred the horizontal plane to the eddy waters along the shore of the river.

HORIZONTAL MEASUREMENT.

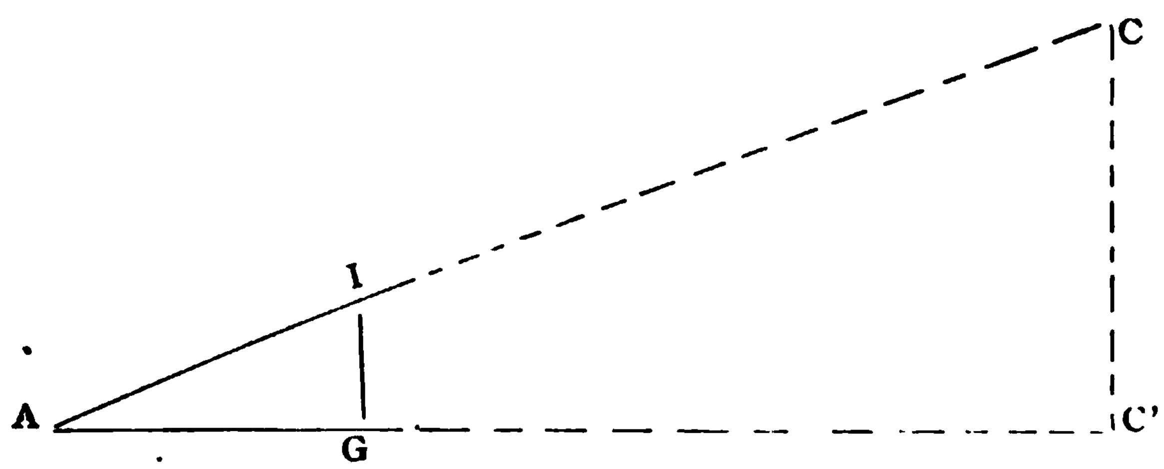
To ascertain the perpendicular height of a point on top of the mountain, above the level of the river at C, on the edge of the precipice.

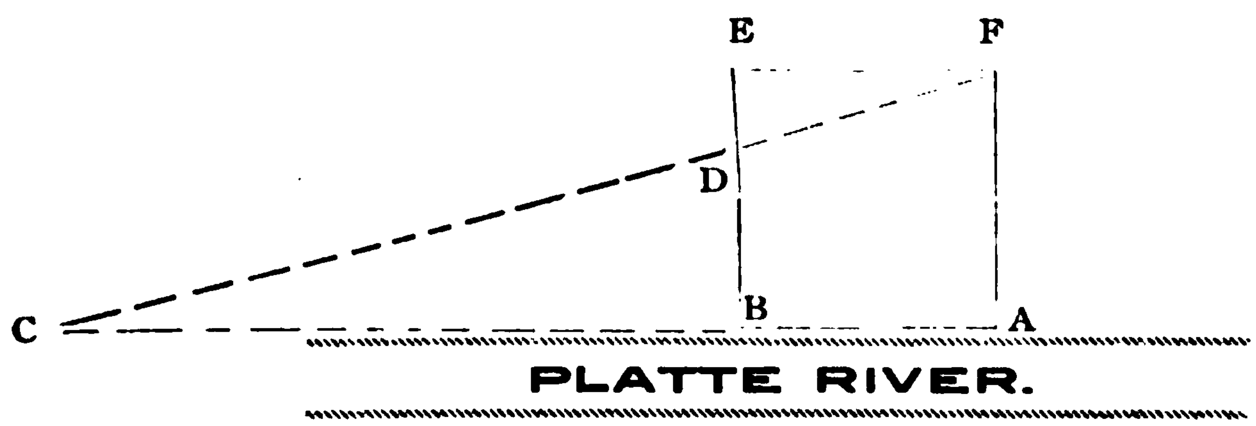
The point A was established in the edge of the river, on the line A C.; A B was measured 540 feet, B being also in the edge of the river, and both A and B in shallow, still or eddying water, above which a paved bottom of boulders projected, on which a person could walk and keep out of the water. The lines A F and B E were each measured 200 feet, at right angles to A C, and the line E F, as a matter of course, was equal to A B, 540 feet; at the intersection of the lines F C and B E the point D was fixed, which was 188 feet from B and 12 feet from E.

Now, the rectangle, A, B, E and F, is divided by the line F D, making the horizontal triangle E, F D, which is similar to the triangle A, C F; then we have this proportion: D E: E F:: F A: A C, in which D E, E F and F A are all known to find A C, the horizontal distance. Hence—

12 : 540 :: 200 : 9000

Therefore the horizontal distance from A to C is 9000 feet.





We now measure on the horizontal line A C along the water a distance A G, 100 feet; at A a point is fixed 4 feet above the level of the water and at G a pole is set perpendicular to the water, and an observation taken from the point above A to the object C; the line of sight cuts the pole 15.9 feet above the water.

We now have the vertical triangle, G, A I, similar to C' A C. Hence we have the proportion,

G A : G I :: C' A : C' C,

in which G A, G I and C' A are known to find the vertical distance, C' C; whence, 100 : 11.9 :: 9000 : 1071.

Therefore, the vertical distance of C' C is

1071+4=1075 feet.

DISCUSSION.

The Chair—Gentlemen, are there any remarks to make on this paper?

Mr. Varney—Mr. Chairman: There are some thoughts occur to me th I feel like talking about, but I am not certain that we should take the tim

The Chair—Our time is limited, that is true.

Mr. Varney—Is there anything else to come before us?

The Chair—The Committee on Legislation has not reported yet. don't know whether it is ready yet or not.

Mr. Varney—I know that we are to adjourn early, and I don't want to take time.

The Chair—There are some papers that we passed in the early part of the morning session. I don't know whether the persons are in yet or not. We don't want to miss any one. "Photography for Engineers," by R. H. Lee; is he here at this time? He does not seem to answer. "City Surveys," by W. A. Ginn; I believe he is not here. "Committee on Blanks and Instruments," Mr. Davisson. He is not here yet. Mr. Bowen, is the Committee on Legislation ready to report?

Mr. Bowen—No, sir,

Mr. Varney—I want to say a few words that are suggested by the paper of Mr. Pampel, and that is in relation to the possible accuracy of surveys. I have never placed much stress on this in any talk that I have indulged in before this society, because I regard that as of secondary importance in surveying. The matter of prime importance is to set monuments so that those who follow you may know what you have done. I regard that as the sheet anchor, and if a man will do that I will forgive him all sorts of inaccuracies —I care but little about them. Nevertheless, I do feel just now like replying to some implications in that paper. I do wish to say that a higher degree of accuracy than probably is generally attained can be attained; I do not believe in the impossibility of a high degree of accuracy in making measurements, and I insist that it can be done. Now, I insist that in a survey of a hundred all round, there is no necessity of an error of either latitude or departure of more than four-tenths of a foot. I regard that as the limit with which a person should be satisfied. I don't say that I always attain that; I

say that life has been a burden to me, as well as to the rest of you, a great many times because a survey would not balance within five, six, or even ten or fifteen feet. But I do say that it is possible. I do say that when our surveys do not balance within that limit it is a proof that some of our work has been carelessly done. Now then, as to how it is done, I want you to cut me off if you wish to. I don't want to bore you with talk. I want to go to the university, but I will just briefly state how I make my measurements. In the first place, I never have two chain men, I always have hold of one end of the tape myself, I have a man to help me, and he carries the hind end of the chain or, if he is a skilled man I send him ahead, but the best man belongs ahead the rear man has just two things to do he is required to keep you in a straight line (you have something ahead, and in lining up if a point is in a thousand feet, if it is more than six inches out of the line it is inexcusable, I don't say we don't get more than that out, but if we do there is one of the reasons why the survey does not balance. But there is no reason for getting more than six inches out of line in a thousand feet.) To do that, the rear man holds the zero of his tape over the pin; with the tape as a sight, he sights along the tape, and I stand to one side; suppose I am measuring this way I stand to one side, with the tape in my left hand, and he sights along the tape, and I hold it high or low, as he directs me, so that the line of the tape may strike the point at which he is aiming, if he is on high ground, I hold it up here; if low, I hold it low, and he gets his eye down nearly to the tape and sights along, I hold the tape in my left hand and the plumb-bob in the right, and when he says "all right" I drop the plumb-bob and it strikes the groud, he pays no further attention to me, his business then is to hold the zero of the tape over the point. He uses the plumb-bob in his right hand and the tape in his left, he lets the tape rest on his leg, or somewhere where he gets the strain, my instructions to him are that that tape must feel as if it was hitched to a nail—it must be solid, while I am getting ready at my end, he is getting the zero over the point with his plumb-bob; when both are ready, and he knows when I am ready by this: as I am bringing my plumb-bob to the right place I am at the same time drawing a steadily-increasing strain until I think I have twenty pounds, when I have it, he knows that I am right by that, he knows about what twenty pounds is, and he calls out "stick," and holds still until I make a little depression, and he feels that jerk on the tape and loosens up, by that depression I let the plumb-bob strike again I put a pin into it, slanting, so that he can plumb onto the pin where it goes into the ground, and I put it in very carefully, so that the center of the pin is at the point of the plumb-bob and go on and repeat the process. With a little practice this can be done very rapidly and very exactly Of course, if we are going down hill or up, we only take a part of the tape On long distances, if we are going up a hill, I leave a point at the bottom and go up and measure it down. You can do better that way I have said what I wish to say, and I wish you to bear me out. I wish you to bear in mind that this is the first time I ever talked this way to this society, because I regard this as secondary I do insist that good measurements can be made, however, and that a high degree of accuracy can be obtained and very rapidly also.

Discussion of Professor Brown's Paper.

"WHAT KNOWLEDGE SHOULD BE REQUIRED OF SURVEYORS TO QUALIFY FOR PRACTICE."

Mr. Wileman—Professor Brown mentioned my name in connection with Australia. I will say that all surveyors in Australia are required to be licensed and have a maximum fee fixed that they may charge. I don't suppose they are prohibited from charging less, but they can collect that at law as the maximum—two guineas a day. I am not familiar with the detail of the requirements in South Australia. but I know they are required to have served at least two years with a licensed surveyor as his assistant, and are recommended by him, and I think another one—two licensed surveyors to recommend him.

Prof. Brown—Very much as it is in Canada.

Mr. Wileman—Yes, sir; I think it is almost identical with the Canadian practice.

Prof. Brown—Do they have an office that corresponds with our county surveyor?

Mr. Wileman—No, sir; because the land office is run by the government. All the work of original land surveying is done by the surveyor general in that office, and the private work is done by the licensed surveyors who have no official position other than their license.

Prof. Brown—Do the surveys they make have to be recorded?

Mr. Wileman—If a surveyor makes a survey for a transfer of land it has to be recorded. I don't know that surveys that do not involve a transfer have to be recorded.

Prof. Brown—How about the transfer being made having a description in it? Does this description have to be submitted to the surveyor?

Mr. Wileman—Well, as to any specific requirement saying that the description must be submitted, I don't know that there is one. But as the survey or plat is incorporated with the title, I suppose the description is written by the surveyor at the same time that he makes the plat.

Mr. Davisson—I simply want to state one fact that Mr. Brown spoke of in regard to bridge building. When the bids are left entirely to the bridge companies, they will go to work and make their plans for the floor system about the same as the truss. I think that is a great mistake myself. I have had some experience in that direction, and whenever I draw plans for a bridge for our county roads, I always make the plan for the floor system a good deal stronger than I do for the balance of the members, for this reason you may figure the truss or make specifications that will run from seventy five to a hundred pounds to the square foot; now, I will make the floor system for the same truss run from a hundred pounds up as high as a hundred

and twenty. If you run a traction engine on the bridge, you will find that, as far as the truss is concerned, it is all right, but when it comes to the floor system the force is entirely concentrated at one point Now, we are getting to have throughout our counties traction engines that will weigh six tons. We had all our roadways that had been made—that run about as the gentleman spoke about—sixty pounds to the square foot, and their floor system the same. The result was we had to take out the old stringers in these bridges and put in heavier ones. They would have their floor joist probably not more than two or three inches by eight, and probably not more than five or six of them in a panel. Those old bridges were constructed, many of them, twenty years ago, and they have to be replaced by one or more sleepers, and increase their size to probably twelve inches. You have it to do, but even then they are plenty weak, when you come to run these traction engines over them. I think that that is a thing we ought to look after very carefully, and be sure we get our bridges strong enough, at any rate Another thing we always do in preparing plans for contractors to bid on is this: We specify the number of panels and the height of the truss on the general strain sheet. And then when the bridge companies bid upon a bridge of that kind, you don't have to go to work and calculate every bridge they bid on separately. If you leave it to the bridge companies, they never will bid on the same number of panels and same height of truss. When you prepare one general plan and strain sheets, you have them for all of them.

Mr. Connor—I agree with Mr. Davisson in regard to the floor system of bridges. The most of the bridges, or at least a great many of them, give the floor system the same capacity as the truss. They are on the same capacity per square foot. If you put your truss on one factor, for instance on a factor of four, then your floor system should be raised to a factor of five or six. One thing Mr. Davisson must remember that is very true in regard to strain sheets, and I think it should be followed in all cases, but the law is against us. The law explicitly says that the commissioners shall do so and so; they shall invite and receive plans and specifications from all bidders and are required to invite them. I have had a great deal of experience in that bridge business, and some very large business, and I know there is the trouble. Even when you specify the length of the spans, they will come in with the length and capacity of the spans changed For instance, you advertise for a bridge of one hundred pounds per square foot with a factor of four. They will give you eighty pounds on the truss and one hundred on the floor, disregarding all the specifications entirely. Bridges to-day that were made some years ago for one hundred pounds capacity per square foot, I have been on them and measured them, and I know they have only sixty You will find it so all over the country. In a great many of our counties the letting is done practically in this way For instance, we will take Morgan county, which advertised for three iron bridges, about three months ago. They said one of them would be a span of about one hundred and seventy feet at a certain place, another would be about

one hundred and twenty-three feet, and the other about one hundred and thirty feet. That was the whole advertisement; that comprised the whole business. There was no depth of truss, capacity, or anything, nor factor of safety. That is all it said—one about one hundred and seventy, one about one hundred and thirty, and one about one hundred and twenty-three. The reason I know about it is that, after the bids were in, I had the privilege of looking at the strain sheets, and they were various. Their bids were about in proportion to the kind of bridges.

Prof. Brown—Usually the bids are inversely as the quality of the bridges.

Mr. Connor—Yes, sir.

Prof. Brown—The poorer the bridge, the higher the price.

Mr. Connor—I think sometimes we get them the other way. My opinion is, there should be some qualification for the business of practicing engineering or surveying, and with regard to Mr. Brown's paper, speaking of the young man who came to college, saying that he was nominated for county surveyor, I happen to know of that case, or one similar, and the party was elected, too.

Prof. Brown—The case I spoke of came from the western half of the State.

Mr. Connor—This one came from the eastern half, and the same county had two cases exactly the same—nominated the man and he was elected. He didn't know how to adjust his instrument, and I adjusted it and showed him how to adjust it. He came to me from the other county, from an adjoining county.

Mr. Davisson—I would say in regard to the bridge matter that I was caught that way once. The first bridge letting we had, we had some seven or eight competitors. There were no two alike. I said I will never be caught that way again. We printed bills and sent to every bridge company in the country, giving general details of what we wanted them to bid on, and we put in our advertisement that no bridge from any company would be considered unless they were strictly in conformity to the plans and specifications, and we never had any trouble afterwards.

Mr. Bowen—You stand in with your commissioners pretty well, don't you?

Mr. Davisson—Frank D. is engineer of Wayne county, Ind. They gave him all the work of bridge building throughout the county. He furnished everything in detail, even to the iron work, and all the bridge companies had to make their bids to furnish material according to his plans and specifications, and I will show you his blanks (I brought them along) in regard to the bridges. Here is the foundation for the abutments, and here is the form for the superstructure. Mr. D. is now, I believe, or was a year or two ago, superintendent of the construction of the Grand Central depot of Indianapolis.

Mr. Connor—I like that all very well, but the law of the State is against

it. It says the commissioners shall invite and receive proposals and plans from bridge companies.

Mr Davisson According to certain specifications.

Mr Connor No, sir, they shall invite and receive plans and specifications from the different competitors. They must admit those plans and go through them. I would much rather have it that way for my part but then if the bridge companies propose any other plans you can't throw them out, because the law is against you

Prof. Brown—I would like to say in regard to those old bridges that Mr. Davisson spoke about, that they had to strengthen the floor system I think there are a couple of other points to be looked to—where the floor beams, especially the beam ends if it was built that way, and it probably was), hang on stirrups, the truss would probably be all right. That method of making the floor capacity considerably higher than the truss capacity is, I think coming more into use all the time as good practice About the factor of safety, instead of specifying a factor of safety of four, five or six, isn't it better to specify that the iron shall not be strained more than ten thousand or twelve thousand five hundred?

Mr Davisson Now, I know a bridge we have in our county that I think was built by the Smith Bridge Company, of Toledo The iron beams were very light, and they found that when they began to run their traction engines over them they got afraid of them, and they went to work and trussed all those beams.

Mr Bowen—Mr. Chairman The old bridges seem to have monopolized the main point at issue and I think the main point of discussion ought to be as to whether it is expedient to have enacted any legislation looking to the qualification of the members of the profession. Now, as far as I am concerned, I am heartily in sympathy with the professor's recommendations, although whether it would benefit me, or whether I would be entitled to a diploma or not would depend upon the restriction put into the law If they were very severe I would probably be relegated to the rear But I would be perfectly satisfied to make the sacrifice for the sake of the good that might come in the future to the profession. We are not only fixing a standard for ourselves, and those young men coming upon the field of action, but we are laying the foundation for the future, and we ought to lay it broad and deep as much as we can And I think a recommendation of this kind, if properly managed, properly formulated and brought to the attention of the legislative body in the right way, would have at least a possible chance of passing. Any effort in that direction heretofore has never met with anything like success, but I believe the measure is worthy of continued effort. I think the whole thing ought to be revised, just as the professor has said, that he has simply laid the foundation for what ought to come in the future, that it ought to be formulated and matured before it goes before any legislative committee

Another idea that occurred to me, aside from what was embodied in that,

was that the scope of practice that any individual should have—not exactly the scope of his practice, but the scope of his jurisdiction and certificates, should be somewhat restricted, to at least within his own knowledge. Now, it seems to me that it is quite absurd for an engineer to take up a plat or paper, or report of a survey, or specification for a bridge or anything else, and put his name on it, and say "this is correct, absolutely," without knowing anything about it. I think it is ridiculous in the extreme, and I cannot conceive how any engineer of average self-respect and intelligence would do it. I know of one exception, however. Now, it strikes me, that it would be just as consistent for a lawyer or doctor to do the same thing. To make the case plain, we have across the street here Dr. Hamilton, a very eminent physician; he has charge of a college, teaching young men the profession; suppose that he would undertake to doctor the people in the city, and would sit in his office and send his students out to treat these patients and then be willing to take the responsibility for the correctness of their work. That don't strike the average man as exactly right. There are but few men who would like to trust themselves to that kind of treatment, especially if they had the grippe right badly. Neither is there any eminent attorney who would trust his important cases to a student who has just commenced reading for the profession. For these and other reasons, I think it would be well to have same kind of a standard of qualification. It is no hardship at all, and the sooner the practice is started the better for the coming generation.—the better for the young men who are starting out in practice. Now, as to the bridge question: I only refer to this incidentally, because I either am not exactly sound on the bridge question myself, or else some of the others do not see it exactly as I do. Now, the idea of constructing a bridge, specifying that the truss shall be constructed with a factor of four, and that the floor beams, or floor system, shall have a factor of six—is that the idea?

Mr. Davisson—Yes, sir.

Mr. Bowen—Now, why that should be I can't see. The proper way, in my judgment, to do is this: To specify the kind of a bridge you want, the number of panels, width of roadway, height of truss, and specify that it shall be constructed in such a way that it will carry a hundred (or a load equivalent to a hundred) pounds per square foot with a factor of four, as against the greatest strain that may come upon any member; now, that not only covers the truss, but it covers the floor beams; you put your six-ton traction or any other kind of an engine on that bridge, and you run it through. When you get to the panel node, or over the floor beam, you have a concentrated load of six tons on one beam. Now, if that beam is not so constructed as to carry that load with a factor of four, it is not up to the specifications; if it carries it with a factor of four, and the truss has carried it with a factor of four, what more do you want? You have got it; of course you might have a different way of telling the thing, that is all. The bridge must provide for the load at every point, and it must be provided for with this

factor of safety. Now, as to the practice of having bridges built on the plans of the bridge builder, or on the plans of the county engineer, that depends entirely upon the county commissioners, who have it in their control; as this gentleman well says, the law makes it obligatory upon the county commissioners to advertise for and receive proposals from bridge builders; they can do this, but at the same time they are not bound to let their contract to these bridge builders on any particular plan they may present; they must look at them—that is their duty as commissioners, but beyond that they are not bound to do anything. Suppose a bridge builder comes along and asks "why you didn't give me that contract?" They don't have to answer, they don't have to say why. If your commissioners see fit to award the contract on their own plan, made by their own engineer, they have a right to do so, and the engineer who gets along that way with his commissioners certainly has plain sailing. I think nine out of ten, throughout the State, don't get along exactly that way. I have kown cases in which bids were received for bridge work and referred to the county engineer, and while he had retired to his office to figure up and determine on the best plan the bridge builders would retire to the auditor's office and very soon have the case settled—have the whole case decided and the award made, some time before the engineer would get through with his calculations. They would notify him that the thing was settled. Now, that is not the customary state of things, but it has occurred occasionally. What we want to do is by education, by proper training at the beginning, to put the engineer on such a footing that he will be respected. That is the only way to do it. You cannot do it by an election, the political engineer don't amount to much. But we want engineers who have the proper training then they must show that they are competent to do whatever belongs to their profession, and that will greatly educate the people to the importance of the business, and it will be on a better footing that way than you can get it in any other way that I can see.

Mr. Weddell—In the early inception of this organization I believe I was a member of it, and I then advocated a standard of qualifications, but somehow or other the matter was let drop. But in reference to the paper just read, I believe this that something of that kind should be done, there should be diplomas issued from this organization, and I believe that, while it may not be the case now, it soon will be that these things will have some weight in determining the place a man is to occupy, I don't see why it should not be in this profession as in others. Take medicine, dentistry, and law, these men are all protected by law, every one of them. As our county affairs are now, it is not a mark of ability to see a man in any position, especially in in the office of county surveyor. He has got in there just as has been said, through probably belonging to the party that had the greatest number of votes. Now he is placed there, and his work is supposed to be correct, whether he knows anything about it or not. And I believe this that if we have a standard of qualifications, and diplomas issued, or anything

else that may go from this body and into the hands of these members, I believe that in time, and that not very far distant, that it will be of use to them, and that a man can be recognized by what he holds as his papers. I believe it, and I think that is the way out of a great many dilemmas we are now in. Now, in the earlier work of this organization, the only thing that seemed to be uppermost in the minds of a great many members was: how much money can I get out of my office? I want so much money; it is worth so much a day or it worth so much. I felt that was wrong, and I think it is wrong now. Make the people think we are worth so much, and then we will get it. As to bridges: I want to say that I think it was in '83, when the high waters were here and swept away a great many bridges; I know in my county, where I was surveyor and engineer, it took away a good many; at one letting six different companies were there, I think; I figured out the strain sheets of these companies, and there were but two of them that would work up to what they proposed. One of the commissioners came to me and said: can you do this or that with reference to this bridge company? The trouble is everywhere, so far as I know, that the commissioners have ingratiated themselves into the graces of the bridge companies, and some of you know what the results are.

A Member—A year ago I found but one out of seventeen bridges that would work up to the requirements.

Discussion on Paper by G. L. Innis.

"LAND SURVEYING."

Mr. Bowen There is just one point in there that I think is worthy of "hitching onto," figuratively speaking In referring to the survey that he made by order of the court, he proceeds to detail how it was done, and how he reported to the court, and the judge confirmed the survey, and then he says he that he was right Now, that is the point, for this reason that nine times out of ten well, we might say invariably, when a competent surveyor goes and carefully makes a survey, and fixes the points, he knows more about it than the judge of the court, so, when the judge confirms his work he is certainly right.

Mr Innis—Mr. President We had another case right close to the city here, on a free turnpike in which the county surveyor (at the time Mr. Kinnear) went and fixed the corner, a deputy sent by Mr. Kinnear went and fixed one, and he asked me to go over and repeat the survey, which I did, and we didn t come three inches apart at that point Some one got wind of a fellow who had been merely acting as a helper, never had studied the science at all and in fact didn t know much about the higher mathematics. He went over and ran the line off some two or three rods one way. The people on the other side took a notion that they could get two or three rods more of land, so they enjoined the commissioners from building the pike until the corner was decided. After they were enjoined, I went to survey some land for the adjoining land owner, and I asked him to furnish me a man who was a good digger an Irishman, if he had him. I went to the stakes where we set them and told him to dig around there until he come to the natural ground the gravel was filled in there three or four feet. He dug down three or four feet until he found a stone, but it so happened that under our stakes he came across an old stone that looked like a corner stone Even after that the people were foolish enough to go into court over it, and the court went out and invited some of us to go with him and show him the line. He took all the pains he could to inform himself, but he decided that that old stone was the proper corner Of course, they paid their own costs. I speak of this to show the evil any one can do by careless work it gets neighbors into quarrels and expense for nothing and I think no one ought to be permitted to practice our profession unless he is capable

Prof Brown I am very glad indeed to have heard Colonel Innis following in this same line that I spoke of, and I think it shows that there ought to be something done about it. I might say that the examinations or requirements that I had in my mind were not such as would take a man of years of experience to pass, any more than a law student could stand some examinations that it takes a lawyer of experience to pass, or that a young

physician would pass an examination that such a physician as Dr. Hamilton could hardly pass.

Mr. Innis—Mr. President: I would like to say that I think it needs another qualification, besides the qualifications we get in schools, although we cannot do without that. That must be the first step. But they should be thorough. Now, I was a member of the county board of school examiners here for eight or ten years, and during that time I had a gentleman come from Delaware from college, and he stuck a diploma in my face as a recommendation of character and as a recommendation of his qualifications, and he wanted me to issue a certificate on that without any further examination, or wanted the board to issue a certificate. We told him we didn't do that, that since he was so well qualified, he would have no difficulty to answer our questions, but he couldn't answer a question correctly; he could scarcely answer one in common arithmetic; he didn't know anything about English grammar at all, and we refused him a certificate. He got on his ear considerably, but we couldn't help that. Not very long after that, a State school commissioner, just before he took his office, came to the city, and I invited him to come home and stay with me until he got a place to move his family to; he did so, and during that time I invited him up to one of our examinations. There were twelve young ladies that came from the high school, and each one had a diploma from the high school in this city, and I put them in a class by themselves, and I thought it would show off Franklin county before the school commissioner, and he would start off with a good opinion of our school; but, unfortunately, not one of the twelve could answer any difficult question in common arithmetic. I thought perhaps they had been through the higher branches and had forgotten arithmetic, and I asked what a right-angled triangle was. That went all around the class. Finally one young lady held up her hand, and I told her she might answer—very glad to hear her, indeed. "Well," she said, "a right-angled triangle is a triangle with three right angles." The commissioner said to her, "The Almighty couldn't make one with two." So we want other qualifications besides the qualifications of the schools for a man to make a surveyor.

Prof. Brown—I recognize the fact that mere book learning would not do the business. I said a man must have common sense and some practical experience, and I think a young man before being licensed ought to have one, two or possibly three years, a sort of apprenticeship with a practical surveyor, go out and pound stakes, and carry chain, and so on.

Mr. Wileman—Mr. President: At the same time, in connection with the practical experience of doing the work, I think that for land surveying it is very necessary to have some knowledge of the law in regard to it, subdividing and revision of old corners or establishing new ones. Now, a person may go on railroad work for several years, learn the mere mechanical details of surveying, and be capable of doing ordinary land surveying; but go into county work, retracing old lines and dividing property, and he would

find himself entirely at sea as to what he should do to do justice between the different parties

Mr. Innis—It is not the object to find what the original surveyor ought to have done, but what he did

Mr Judson Mr Chairman I think that one difficulty that we have to contend with in trying to raise the standard of qualifications for surveyors and engineers, is that the public generally, the people who ought to be interested in that sort of thing, don't realize how much trouble a person who does not understand his business can make. Now, as has been said, there are all sorts of people who pretend to be surveyors, just as I suppose there are in every profession. The only difference is that in surveying it is a kind of free-for-all affair. Everybody can buy a compass and chain and start out, but, as I said, the difficulty is in getting them to understand how expensive this sort of an arrangement is for those who have property to divide up. Now, to relate an instance, we have in our place at Sandusky a man who, ever since I have lived there, has pretended to be a surveyor. He is a sort of map maker and he is equipped with an open-sight compass and jacob-staff, and has a chain that perhaps would weigh ten or fifteen pounds, and pins and things of that sort to correspond He actually pretends to do it, and does do city surveying, and he occasionally gets a job, and, in almost every instance, that job goes into court. That is only an illustration of what we have to contend with, and it seems to me that the only way in which we can raise the standard and better the condition of affairs is for each one of us to unite to set about in our own county or district in which we are located to do what we can towards influencing those who are in authority and those who would have influence with the legislature, so that when anything of that sort is brought up we can handle it and get it into shape.

A Member—Mr. President Another thing with regard to parties starting out. I will relate a case that I know of, he was a helper for quite a while, and he took a notion he could do surveying as well as any person, and he got hold of a telescope compass with the cross-hairs out, and he actually ran lines for two years without any cross-hairs in it. There happened to be a little point on the object glass right under that, and he saw that and thought that was the sight. He came to Mr. D—— one day and said that had got knocked off, and he wanted Mr D—— to fix it for him Mr. D—— said, "I don't see any cross-hairs." "Cross-hairs, what are they?" Mr. D—— said, "There are no cross-hairs in there." He said, "I don't see what you mean." He said, "There have not been any in it since I have had it, and I have had it for two years" and he was pretending to do surveying with that instrument When he moved it he took it on his arm and carried it like a basket this way (illustrating Those are the kind of men we have to contend with.

Prof Brown Was that in Morgan county?

Former speaker—No, sir; that was in Muskingum county. The party lives in Zanesville.

Mr Bone—I have been a member of the society ever since the begin-

ning, and we have been trying to fix some standard, and we are not willing to give it up yet, although we have failed partially. A great deal depends upon ourselves. I think that in some cases our efforts have already been recognized. I know of cases in the courts of our counties where, when cases of lines come up, that they refer them—in one case, at least, where there had been considerable of a lawsuit, and when the case was brought up before the judge and he saw the state of matters, he said, "The county surveyor is better qualified to decide that matter than I am, and I will just refer you to him." He didn't try the case at all, but he appointed the county surveyor to go over the line. He had confidence in him, and he wouldn't have anything to do with the case at all. He made them agree to that, recognizing that a practical surveyor that was well qualified for the work had better opportunities to fix and determine the lines than the judge on the bench.

Mr. Innis—The judge asked me to be very careful about my work. He said, "You can determine that thing a great deal better than I can; you ought to come very close to it." When I made the report to him I made it full, showing how I worked it out. He said: "I had a training once in that kind of knowledge, but I have forgotten all about that. There can't be any two ways about that; it must be correct." You have to take the testimony of the individuals who own the land on either side, that is, the court would have to take them, and I think all old surveyors would say that a man's opinion about his own land is not worth anything at all, unless he can point you out a cornerstone or some landmarks that were original corners. That, so far, is good, but I have myself dug and had others dig more than half a day for a stone that I helped to plant myself on my own land, and if I could not guess any nearer than that, being a surveyor at the time myself and wanting to find it, I would like to know how much any person's opinion was worth who knew a great deal less about it.

Discussion on Paper by J. L. Culley.

"TRANSIT POINTS."

A Member—I wish to say that I was much interested in that paper of Mr Culley's, and I thought back to the time when the Chinese invented that cumbersome compass for the land surveyor which stood upon a wooden wheelbarrow That is actually in use to-day, although it was invented over four thousand years ago. I was wondering what a Chinaman would think if he would come and look at these instruments we have here to-day. I think he would come to the conclusion that they were premature births in different stages of gestation, when he would see that perfect little transit that we can put in our pocket and carry around, and which is not nearly so small as some that have been made. I was also much pleased to know that Mr. Culley has given us some suggestions in regard to the construction of instruments that our instrument makers have been anxious to know. Our instrument makers are not persistent in carrying out their own views. They come here to ask us what we want, and they say, "tell us what you want, and we will produce it for you." Now, if there are improvements that you want to see made on the transit of to-day, suggest them Mr Culley has gone into this quite exhaustively, and I hope he will pardon me if I ask him to read a sentence or two over again, for I did not catch it, in regard to his views on the power of the telescope I have been very much pleased with it. I have had some very severe trials by reason of having a transit that was of too high power and that the focus was too far off, which prevented working close up to you. I simply speak to commend the paper rather than to criticise it.

Mr Davisson—Speaking of that high power, I have a high-power instrument, too, a Heller & Brightly, and the only trouble I have with that is on a dark, foggy day in attempting to see an object off some distance, I often can see it plainer with the naked eye than through the instrument. It magnifies that fog and mist to such an extent that I can hardly see anything at all.

Prof. Brown—A word in regard to the inverting telescope. I worked on the Scioto Valley a little while with Mr. Griggs, some years ago, and I used an old English theodolite that inverted. The telescope gave an inverted image, the first one I had ever seen or handled, and if you wanted the rod man to go one way it seemed very queer to motion in the opposite direction. During the last year I have bought a new level for the university, and I got it with the inverting telescope. I was very curious to see how the students would take hold of it. They had been used to the direct telescope, but after they had practiced with the inverting telescope for a couple of hours they got so that they could read the figures that were upside down—not quite as quickly as if direct, but in a very short time, in a few hours, or half a day,

it would come easy for them to motion with the hand in the opposite direction. I might say in regard to the same thing with amateur photographers. They all work with the inverted image. If you put your head under the cloth, the image is inverted. There is no trouble in focusing. There is an advantage to be gained in the matter of light, the point that Mr. Davisson speaks of, that he had trouble on a dark, cloudy day. If he had had an inverting telescope, and an inverted image, he could have seen much better than in the telescope he had. The difference is very marked.

Mr. Wileman—Nearly all the English instruments have the inverting telescope, and they use them at the present time. They furnish either the direct or the inverting telescope, whichever you wish, to use with the same instrument.

Mr. Innis—There is one thing in reference to the transit that I have often thought would be a great convenience, and that is a set screw, like the old compass set, set at right angles with the telescope. Nearly all surveyors know what that means. Along a fence row grown up you have to go off ten or thirty feet from it to trace your line. Now, it would be very convenient when yon have this line, this offset line, to go and set your instrument and get on your fore-sight ahead at the further end, and then have something to get the right angle without having to turn, If you only had ten or twelve feet of a set-over, a good compass set would get the center of your flag pole. The last time I sent my instrument to have it repaired, I asked them to put such a set on, but it came back without having it on.

Mr. Strawn—I am happy to inform the gentleman that a great many of them are made in just that way. They are also making a transit with a little right-angled telescope for precision, not expensive, but which is still better. These appliances are found to be very desirable, but there has been for years just exactly the features that Mr. Innis asks for. I want to say further, in regard to the improvements, that our country has sent abroad in regard to the transit and level. It was noticeable at the Centennial that when the Chinese and Japanese came here, to see the interest which they at once took in our surveying and engineering instruments, and while they had their tubes with water in them to get their levels, seeing the engineers leveling, they gathered together at once where they were laying out the foundation for the government display building, and they talked together in their way; then they went off, got their delegates, came there, looked these over, got an interpreter to know where they could get these instruments, and my friend —— informs me that they have sent quite a lot of surveying istruments to China, and that they came to New York and looked through their factory. That shows what we are doing for the world, and I am glad to know that these improvements are being sought after by instrument makers as well as by surveyors.

Mr. Culley—There is one point that I spoke of in the paper that the members do not seem to understand. A number of years ago I made a mine survey, and I noticed the trouble was to bring the zeros together, and

I studied over the problem to arrive at some way to bring the zeros together. It happened shortly after that that I was called in on a joint survey, and they had an instrument that was so arranged that by placing the lower tangent screw directly opposite you could bring the zeros quickly together, and it struck me that if we could have an arrangement of that kind or some modification of it, it would be a great convenience. I had a little screw put on, and I found it a great convenience in surface work as well as inside work by bringing the instrument quickly to zero.

Mr Bone—I would like to ask the representative of Kueffel & Esser why when aluminum has got as low as four or five dollars a pound, and it only takes a few pounds, why they can't make them out of that as well as brass and save us carrying several pounds?

A Member—I think I can partially answer the gentleman's question in regard to aluminum — manufactured a couple of instruments with aluminum in them, and they were taken up into the mountainous districts of the West, but they were too light, and since then they have not made the attempt to introduce these instruments. The instrument must be heavy enough to resist the shock of the wind. There is one very noticeable feature in the instruments displayed here, they are lightened up.

Mr. Bone—I know that they claim these skeleton frames to be a great advantage on account of lightness, and I thought aluminum would be a great deal lighter

Mr. Innis—I think there are other qualities about a transit that we want rather than lightness. I would rather carry a heavy transit and have a wheel that has some size to it, a wheel of good diameter, so that the graduations upon it are plainly seen, and there is less liability to make a mistake. Take that little transit there. It is so very small that you would have to take a powerful magnifying glass to see that at all. I don t know as you could hardly run the degrees there, they are so small. I like a transit with a wheel, say eight inches in diameter, and if I want to do nice work I think I would carry it a great many times.

A Member—There is one thing I would want in a transit for city work, and that would be not too small an instrument, but as light as I could get it. On a hot day I would rather carry a light instrument than heavy ones, but I would like to have a clamp that would hold the telescope in position to do the work in running out line and level stakes, so that when you set it you could hold it there, doing away with the leveling part, the level attachment. I contemplated getting an instrument of that kind some time ago. That would be the way that I would want it. I would want all the attachments taken off except a clamp that would hold the telescope in place. I guess you get my idea on that. I will show you what I mean, some arrangement right here (explaining from the transit), so that when that telescope was placed in any position it would hold it.

Prof. Brown—There is one attachment, or one matter in connection with transits that has not been mentioned, and that is stadia wires. How many

of the members have made any use of them? How many think they are of no account? How many have ever tried them? They are used in some surveys. They are used on the coast survey and on some of the state surveys. I have had my students make some surveys of that kind, and I have been astonished how well simply a transit with a couple of extra wires in it, and a twelve or fifteen-foot pole, self-reading pole, a transit man and a rod man could do the work. It is a good deal better than the work that can be done with a compass and chain. I know very few of us use the compass and chain alone. With the stadia wires you will save in a hilly country a great deal of time, and in a hilly country I think you can do a great deal better work than with a compass and chain.

A Member—I would say what I would further want would be these stadia wires, but I would want them perpendicular instead of horizontal. I would want also a low-power telescope.

Prof. Brown—There are two ways of holding the rod, either in a vertical position or at right angles to the line of sight. The first way is better; it is easier done. My students ran around a piece of land on the university grounds. It was not very rough, with a traverse or distance of something like a mile or such a matter. We had an old Gurley transit that had been used for eighteen years, and knocked over a good many times, of course, not used as well as it would be by a professor, and still with that old machine, in running around that, it closed less than a foot on levels, and in latitudes and departures it was less than one in three hundred. It was as good or better than the average compass and chain worked.

Mr. Wileman—I would say that I have used it sometimes in trial surveys, in crossing flooded streams, and I have found it accurate.

Mr. Innis—That is about the hardest thing we have to do, is to get a line well measured. A great many have an idea that whether a man ever had hold of a chain or ever saw one before that they can take hold and measure off a line and do it correctly, and without a chainman who can measure a line twice and make it alike, surveyors are going to run into errors right along. It is as important that this is well done as that a surveyor should keep his notes correctly. I remember not long ago I was trying to get the center of a piece of land in the city here that was twelve hundred feet long. There was a street down through the center, and I wanted to get the center of that street. I took a man along that said he could measure as well as anybody, and I measured it over four or five times, and we couldn't come within less than eight inches of each other. I went back and took one of my old helpers, and the very first time we came within not to exceed a quarter of an inch. That was the difference. As I said before, without good measuring the surveyor's work is of no use for accuracy.

Mr. Davisson—Talking about measuring, I will give you my experience. In 1874 I worked on the coast survey one summer, and we wanted to measure a rough place in back of Watertown, N. Y., to connect it with the lake survey, and measured a line there somewhere between a mile and a half and

two miles long. We measured with a ten meter chain. We had some rough ground to measure over, a number of stone fences and several other obstacles in the way, and we measured that as carefully as we could, and measured that line four times, and twice we came out within four inches of the two measurements, and the two extreme measurements were twenty inches apart, and I think we did the work as carefully as we could.

Mr. Innis—Mechanics don't always measure accurately, even carpenters, although they make the best measures I get hold of, without experience, I mean. I remember a case where we were laying the walls for the intermediate penitentiary at Mansfield. I was there with my transit to measure the squares and we wanted the front about eight hundred feet long. I took the young man who was helping me, who was a good chain man, and I measured off the distance and set a stake at either end. The architect thought he would test my work, and he asked to borrow the chain, and I loaned it to him, a one hundred-foot tape. He went to work, and he couldn't come within eight inches of it, because he bent it over a big stone and didn't pay any attention to the declivity of the ground, and he fell about eight inches short; he could not come within eight inches of my stake. He said I was too long. I said "You will come to that stake or you lack in your length." He said that chain was wrong, it stretches or something else. He went and bought a new one and paid ten dollars for it, and came back and measured it over, with the same result. When the foundations were laid we measured straight through, and, if anything, my line was a little too short; it lacked about a quarter of an inch. That didn't make any difference, however. So, you see it takes a good deal of care. You must have your chain every time perfectly straight and perfectly level, or you get too much length on your line, and, consequently, you don't get as many acres as you say you have.

Mr. Wileman—The greatest trouble I have found in getting raw help to do accurate measurement is in using the plumb line. They won't wait until the plumb is steady to drop it right; in fact, they don't want to use a plumb line at all, and won't hold the lower end of the tape high enough.

Mr. Davisson—I simply want to make a suggestion that we have a little time before dinner, and, if Mr. Varney is not ready to report, that we have this gentleman here who has the instruments to give us a little explanation.

The Chair—I think that would be a very good suggestion.

Mr. Link—Well, you know more about the instruments than I do, and I ask the gentlemen to examine the instruments, and I would like to know what you think of them. You know more about it than I do.

The Chair—Mr. Link desires an expression about the instruments.

A Member—I see one improvement that I would like to have on my instrument, that is, a level screw or little screws here (indicating) to loosen or tighten them, for I find in very cold weather the screws of my instrument work very hard. I think that is a good thing.

Report and Discussion on Test Case.

The president called upon Mr. Strawn, ex-county surveyor of Columbiana county, to report on test case carried through the courts to obtain a decision upon law, passed in 1883, requiring records of surveys, etc.

Mr. Strawn—I don't know how many county surveyors are present, or how many ex-county surveyors are present that were county surveyors at the time the lawsuit was commenced against the commissioners. Those of you present will remember that a law was passed some years ago requiring all surveys made by county surveyors to be recorded. Part of the county commissioners refused to compensate the county surveyors for making these records. In some counties they paid it, but in a majority of them they did not. Columbiana county refused, and when I went out of office as county surveyor, I presented my bill, and the bill was rejected. I then got the opinion of the attorney general, General Lawrence, who sustained the position of the surveyors, and said that the county commissioners should allow a reasonable compensation for recording surveys. That opinion was disregarded by the county commissioners also, and proceedings were commenced against the county commissioners in the common pleas court to compel payment. The common pleas court sustained the opinion of the attorney general, and said that the county surveyors should be paid for recording their surveys. The county commissioners appealed the case to the circuit court, and the circuit court reversed the decision of the common pleas court, and the case then, by the advice of a number of the surveyors of the State, was carried to the supreme court. It went along and came up in its order. Judge Ambler, acting for the surveyors, tried to get a favorable decision, and the case was reached several months ago in the supreme court, and the supreme court sustained the circuit court; in other words, the decision rendered by the common pleas court and the opinion of Attorney General Lawrence was reversed. That is the condition of the case, and that is the end of the case, except this, that the costs in the case have not been paid, except what I paid myself, which are probably something more than eighty dollars, out of two hundred and something. I would like very much that we might have a little conference of the county surveyors to know what we should do to meet these costs. The attorneys have not been paid for their services, and the clerk of the circuit court has not been paid, and other bills. I should like to hear from anyone here in regard to what we shall do, whether or not there shall be a committee appointed of the surveyors who are willing to make provision for meeting these expenses. Mr. Hoover is here, probably he has a word.

Mr. Hoover—Mr President I will say that I did not know how the case had gone or what the result had been Mr. Strawn has given us the end of the case I presume the better way will be to have a committee appointed to ascertain whether the association at large ought to pay for it, or whether the county surveyors should aid Mr. Strawn in paying for it. For my own

part, I never made any records in my office that I expected any particular pay for from the county commissioners. I leave it to the sense of the surveyors present what ought to be done about it.

Mr. Strawn—I would say that I have here the receipts for the payments I have made, and also the bill of Judge Ambler, who prosecuted the case. I will say that it was first tried before the county commissioners on July 6, 1885. Judge Ambler, for his services before the county commissioners, charged twenty-five dollars, then trial in the common pleas court on November 4, 1886, he charged twenty-five dollars for that in 1887, January 21, services for trial in circuit court, a charge of twenty-five dollars for that, and the incidental expenses were two dollars; also docket fees, five dollars, and express charges, twenty-five cents cash, for printing records, ten dollars, preparation of brief for the supreme court was one hundred dollars, and for printing the brief to the supreme court, was fifteen dollars, Judge Ambler's bill is two hundred and eight dollars for the entire amount. I believe I reported to this association that the best information I could get, it would cost about two hundred and fifty-five dollars to carry the case through. He has credited me with thirty dollars, having been paid for docket fees and printing records, leaving one hundred and eighty-seven dollars due Judge Ambler for his services. There has been paid by me for sundry items, printing of circulars, postage, etc., including the thirty dollars, sixty-nine dollars and fourteen cents. There is a bill of the circuit court clerk of fourteen dollars and eighty-five cents, making a total of eighty-three dollars and ninety-nine cents. Then I have received from surveyors throughout the State in all forty-eight dollars. That will lessen the amount to be raised. It leaves an amount of two hundred and thirteen dollars and ninety-nine cents unprovided for.

A Member—Was there a motion in this association to have that case prosecuted?

Mr. Strawn—I am not right clear about that. Do you remember, Mr. Buck?

Mr. Buck—I don't remember that there was any motion by the society.

Mr. Kinnear—It seems to me if there was a motion by the society that the society ought to pay it.

Mr. Strawn—I will say that I am willing, although I make no charge for the time I put in, attending four different times at the county commissioners, at the common pleas court and circuit court, although I have made no charge at all for my time, I am willing also to pay this entire eighty-three dollars and ninety-nine cents out of my own pocket if you will provide for the balance.

Mr. Hoover—That would make about one hundred and thirty dollars, wouldn't it?

Mr. Strawn—About one hundred and thirty dollars, yes, sir. I would like to know how many surveyors, county surveyors, and those who were county surveyors in '84—I would like to see the hands of all who are or were

Five or six, probably seven or eight. Of course, those who have been since would, in a measure, be interested.

A Member—Do I understand that this action was commenced by order of the society?

Mr. Strawn—It was commenced in the society, but I did not say that it was an order of the society as a society. Of course, this commenced originally as a society of county surveyors, and this case goes back a good while, and it was afterwards called the County Surveyors' and Civil Engineers' Society.

Mr. Varney—My recollection is that it was talked over before the society, just as now, but that there never was any action taken by the society in reference to it, but it was left to private individuals to do what they chose. I think the society never took any action on it in any way.

Mr. Strawn—I would say, gentlemen, that I went to the State records and got the names of all the surveyors who were in office in '84, and all since that time, and addressed circulars to all those surveyors, but the responses were not as I had expected or hoped.

The Chair—Gentlemen: You have heard the report of Mr. Strawn; what is your pleasure in regard to the matter?

Mr. Kinnear—I make a motion that there be a committee of three of the oldest members of the society appointed to take that matter under consideration and report to-morrow. The motion was carried.

The Chair—I will postpone the appointment of this committee until after supper.

On motion an adjournment was taken until 7 o'clock p. m.

The Chair—A committee, consisting of F. M. Davisson, Frank A. Bone and Oliver H. Hoover, was appointed yesterday to report to-day on this matter of Mr. Strawn's. That committee is ready to report.

At this point the report of the committee was read by Mr. Bone.

Report of Committee on Court Decision, appointed by the Ohio Society of Surveyors and Civil Engineers, January 21, '91.

The commitee appointed to consider the matter of the cost incurred in the prosecution of the case brought for the purpose of obtaining a court decision upon the statute relating to compensation of surveyors for recording of plats of surveys, and by a general agreement said case was to be prosecuted in the name of J. B. Strawn, surveyor for Columbiana county, O. And whereas said case was prosecuted in good faith on behalf of the county surveyors of Ohio: Therefore be it resolved: That it is the sense of this society that the county surveyors of Ohio should pay so much of said costs and expenses as have not already been paid by said J. B. Strawn, and amounting to one hundred and thirty dollars ($130.00).

Second—Resolved that a circular be issued to all the surveyors of Ohio who are now or have been county surveyors since the enactment of said statute, giving a synopsis of said case and the decision reached in said case.

Resolved that to meet the costs and expenses of said case an assessment of

five dollars be made upon each surveyor as aforesaid, and that all sums so contributed be sent to J. B. Strawn, who is authorized to receipt for the same and make report to the society at its next meeting. If it is found that more than one hundred and thirty dollars shall be paid in, a proportionate rebate will be made of such excess of funds.

F. M. DAVISSON,
FRANK A. BONE,
OLIVER H. HOOVER,
Committee.

Mr Bone—I would say also that I think Mr. Strawn deserves it and that he has helped the county surveyors in a great many cases and tried his best to get a decision in favor of the surveyors

A Member Does that report bind this society in any way?

Mr. Bone—Oh, no, the assessment of five dollars has been paid by many, but not half the number to which the circular is sent will pay any attention to it at all, but those who see fit and think it is their duty, will respond to it, and he will make a report of how much he gets, and I don't think there is any danger of his getting a surplus.

A Member—This report don't bind this society?

Mr. Bone Oh no, sir.

A Member—In case we endorse that, are we expected in the future to pay the bill if the surveyors don't pay it?

Mr Hoover—It is only the prestige of this society to assist Brother Strawn in getting out of the hole. That report don't contemplate binding this society in its corporate capacity to the payment of this debt.

Mr. Bowen—Mr. Chairman There are some gentlemen at my left here that don't seem to understand what this is, and the probability is that there are other gentlemen who don't understand it exactly, because it is a matter that originated before many of them became members of the society, I think probably in '83 or '84. You will all remember something about the law governing the duties of the county surveyors. One of the provisions was that he was to record, to plat his work, all his work. That was made mandatory. Well, I believe the county commissioners were given permission to pay the bill if they saw fit, but there was nothing mandatory on their part. Now it seems that a great many of the county surveyors throughout the State made the plat and record according to the requirements of the law, trusting to good luck to get their pay for it, Mr. Strawn among others. Some of the surveyors got their pay without any trouble It seemed to be a matter of of how they stood in with their commissioners a good deal, as I understand it. I may not be right. At all events, they didn't all get it, and Mr. Strawn was one of those who did not get it, although he had the assurance or the opinion of the attorney general and many able lawyers that it was the duty of the commissioners to pay the bill, and that they could be compelled to if prosecuted This matter was brought before the society, which was then the Society of County Surveyors of the State, and those who had similar

claims took an interest in the matter, and agreed, as I understand, to help Mr. Strawn out of this matter, and there was a committee appointed and some kind of a resolution—I don't remember what it purported—but it was passed by the society. The purport of the resolution was that they join Mr. Strawn in defraying the expenses of a test case. Now just how far that bound the society I don't know. I don't know as it is material. At all events Mr. Strawn, at his own expense, has fought the case through the courts until last fall, and finally got a decision in the supreme court, and in that he was defeated. So he has the hardship of not only losing his case, but having the costs to pay, the most of which he has paid, and it is simply asking the county surveyors of the State to contribute what in good faith they ought to, and simply asks the endorsement of this society to that end. If there is anything binding upon this society in this resolution, I don't know it. It might or might not have that effect; I could not say. That is the best explanation I can give the matter.

Mr. Strawn—Mr. Bowen has made a statement of the case very fairly—and the reason probably why I was requested to make a test case was because I had more to lose or more to gain than anybody else, and I have been unfortunate enough to lose the case. The costs have not been excessive, although I think we had as good an attorney probably as could have been secured. Judge Ambler is a man of recognized ability as a lawyer and jurist. It is a case that commenced in '84, I believe, and was not reached in the supreme court until a few months since.

Mr. Burgess—Is there a motion before the house?

The Chair—There is not.

Mr. Burgess—I suppose the constitution and by-laws of this society provide the manner in which assessments may be levied. Certainly this is not the form, and I cannot see that there is any chance that the association as an association could be bound by the adoption of a motion to adopt this report. Is that what you desire, the adoption of the report? I move that the association adopt the report of the committee.

A Member—I second the motion.

A Member—Mr. President: I would suggest that the word approve be used instead of the word adopt.

Mr. Burgess—I accept the amendment.

The question then coming on the motion of Mr. Burgess as amended, it was carried.

The Chair—Is there anything further to come before the convention? If not, a motion to adjourn is in order.

A Member—I move we adjourn.

The motion being seconded, was carried, and the convention adjourned.

Obituary.

When the chair called for the reading of P. J. Laessle's paper, it was a sorrowful surprise for those present to learn of his recent decease. The committee appointed for the purpose submits the following sketch of his life.

Philip J. Laessle was born in Germany in 1828, graduated as civil engineer in 1846 in Carlsruhe, Polytechnicum, grand dukedom Baden, Germany, practiced under said government on railroad protection on the river Rhine with fascine levees, building bridges until 1849, was engaged as military engineer in said year during the rebellion, fled after the rebellion in said year to America, and came to Ohio in 1853 and engaged in farming in Ross county, O.; also in building turnpikes, both as superintendent and contractor, building fascine levees, etc. He was elected county surveyor of Ross county, O., in 1885, and again in 1888, and was elected a member of the Ohio Society of Surveyors and Civil Engineers at its annual meeting in January, 1890. He died very suddenly of heart trouble January 9, 1891, in a street car while on his way to Frankfort, in Ross county, to make a survey. He was on the programme of 1891 for a paper, subject, "Correction and Protection of Streams with Fascines and Fascine Levees on the River Rhine in Germany," which he had not completed at the time of his death.

R. A. Bryan,
J. R. C. Brown,
O. H. Hoover,
Committee.

Obituary.

Through the kindness of Brother Griggs, the secretary is enabled to insert the following clipping from the Columbus Evening Dispatch of March 18, 1891, in relation to the death of Mr. John Lewis, who was one of our honorary members:

Mt. Vernon, O., March 18.—Mr. John Lewis, one of the most prominent and wealthy citizens ot this place, died yesterday of paralysis, aged 72 years. He came to this city forty-five years ago, where he built the substantial and attractive residence in which he has always lived. He was a man of rare intelligence, and before his sickness was active in his profession, and was well and favorably known throughout the State. Mr. Lewis was an authority on astronomy, having contributed much valuable aid to George F. Chambers in his work, "Descriptive Astronomy." At the age of 19 he was professor of mathematics in the Washington, Pa., college, where Hon. James G. Blaine graduated, and as a mathematician he had no superior. The C., A. & C. Railroad stands as a monument of his ability as a civil engineer, he having planned and built the entire road, and Lewis Hall, one of the institutions belonging to Kenyon college, at Gambier, towards the erection of which he gave many thousand dollars, is a memorial of his generosity. Many people in Columbus, where he was widely known, as well as elsewhere, will read with regret and sorrow of his demise.

te Directory of Surveyors and Civil Engineers.

Names in Italics are members of the Society.
Names with a * are those who sent replies to inquiry.

tethy, C. F.	S. and C. E.,	Circleville,	Pickaway.
man, L. B.	S. and C. E.,	Fredericktown,	Knox.
, J. V.	S. and C. E.,	Eaton,	Preble.
y, M.	S. and C. E.,	Cincinnati,	Hamilton.
ew, W. C.	Chief Eng. L.A. & Mo.Ry.,	Youngstown.	Mahoning.
e, H. F.	Surveyor,	Williamsport,	Pickaway.
, D. D.	S. and C. E.,	Bowling Green,	Wood.
ost, E.	County Surveyor,	Greenville,	Darke.
den, L. A.	S. and C. E.,	Ashtabula,	Ashtabula.
erson, L.	Civil Engineer.	Cincinnati,	Hamilton.
lgate, W. S.	S. and C. E.,	Lancaster,	Fairfield.
r, C. O.	Civil Engineer.	Cleveland,	Cuyahoga.
't, J.,	S. and C. E.,	London,	Madison.
t, J. S.	S. and C. E.,	Greenfield,	Highland.
ott, E.	S. and C. E.,	Greenfield,	Highland.
son, M. K.	Surveyor, Ass't C. C. E.,	Glouster,	Athens.
'son, J. W.	S. and C. E.,	Galion,	Crawford.
'ell, S.	Civil Engineer.	Columbus,	Franklin.
d, E. C.	Civil Engineer,	Dayton,	Montgomery.
er, S. J.	Asistant C. C. E.,	Cleveland,	Cuyahoga.
, R. L.	Surveyor,	Coshocton,	Coshocton.
win, W.	Professor of C. E.,	Uni. of Cincinnati,	Hamilton.
idge, F.	Surveyor,	Cherry Fork,	Adams.
er, C. M.	Civil Engineer.	Cleveland,	Cuyahoga.
er, F. M.	Surveyor,	Painesville,	Lake.
es, G.	Surveyor,	Georgetown,	Brown.
ord, R. X.	Civil Engineer,	Canton,	Stark.
ore, F. W.	S. and C. E.,	Paulding,	Paulding.
nore, T. H. B.	S. and C. E.,	Paulding,	Paulding.
tty, J. G.	Dep. C. Surveyor,	Columbiana,	Columbiana.
e, B. B.	Surveyor,	Marblehead,	Ottawa.
s, J.	S. and C. C. E.,	Greenville,	Darke.
htler, W. P.	Co. Surv'r and C. C. E.,	Marysville,	Union.
S.	Civil Engineer,	Marion,	Marion.
'nt, S.	Civil Engineer,	Toledo,	Lucas.
der, W. L.	Civil Engineer,	Canton,	Stark.
n, O.	Civil Engineer,	Canton,	Stark.

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*Binkerd, J. S.	Civil Engineer,	Dayton,	Montgomery.
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*Bishop, W. C.	Surveyor,	Batavia,	Clermont.
Blair, A. Z.	Surveyor,	West Union,	Adams.
Bliss, A. L.	S. and C. E.,	Northfield,	Summit.
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*Brenneman, S. M.	Surveyor,	Orrville,	Wayne.
*Bremmen, E. H.	Civil Engineer,	Port Clinton,	Ottawa.
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Campbell, R.	Surveyor,	Georgetown,	Brown.

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Cassel, H. H.	Civil Engineer,	Mt. Vernon,	Knox.
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Clark, W. P.	Surveyor,	Medina,	Medina.
Clevenger, P.	Surveyor,	Wilmington.	Clinton.
Cole, J.	County Surveyor,	Ravenna,	Portage.
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*Cook, J. D.	Sanitary Engineer,	Toledo,	Lucas.
*Cookston, C. G.	S. and C. E.,	Belle Center,	Logan.
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Coryell, J. L.	Surveyor,	West Union,	Adams.
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Counts, I.	Surveyor,	Peoli,	Tuscarawas.
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Crider, T.	Surveyor.	East Hamilton,	Butler.
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Dimock, E. W.	Surveyor,	Ottawa,	Putnam.
Doak, W. S.	Surveyor,	Winchester,	Adams.
Doane, L. W.	Civil Engineer,	Zanesville,	Muskingum.
*Doddridge, P.	Civil Engineer,	Coshocton,	Coshocton.
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Ellis, J.	Surveyor,	Aberdeen,	Brown.
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Fisher, L.	Civil Engineer,	Akron,	Summit.

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Gear W. C.	S. and C. E.,	Upper Sandusky,	Wyandot.
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*George, J. A.	Co. Surv'r and C. C. E.,	East Liverpool,	Columbiana.
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Geyer, J. L.	Surveyor,	Paulding,	Paulding.
Geyer, A. R.	Surveyor,	Paulding,	Paulding.
Gibbs, H. B.	Treas. King Iron Bridge Co.	Cleveland,	Cuyahoga.
*Gifford, G. E.	Asst. Eng. King I. B. Co.,	Cleveland,	Cuyahoga.
Ginn, W. A.	S. and C. E.,	Bellefontaine,	Logan.
*Good, G. P.	Civil Engineer,	Columbus,	Franklin.
Gore, E. B.	Surveyor,	Georgetown,	Brown.
Gore, J.	S. and C. E.,	Hillsboro,	Highland.
Gore, P.	Surveyor,	Hillsboro,	Highland.
Gotwold, R. C.	Civil Engineer,	Springfield,	Clarke.
Grierson, A.	Surveyor,	Aberdeen,	Brown.
Griggs, Julian	Ass't Eng. Scioto Valley Div. N. & W. R. R. Co.	Columbus,	Franklin.
Grim J. C.	Co. Surv'r and C. E.,	Bryan,	Williams.
*Griswold, W. F.	S. and C. E.,	Worthington,	Franklin.
Guy, W. T.	Civil Engineer,	Columbus,	Franklin.
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Harper, S. G.	County Engineer,	Portsmouth,	Scioto.
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Harvey, J.	S. and C. E.,	Hamilton,	Butler.
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*Henshaw, L. DeF.	Civil Engineer,	Massillon,	Stark.
*Herman, L.	Consulting Engineer,	Cleveland,	Cuyahoga.
*Hersey, G. D.	C. C. E.,	Youngstown,	Mahoning.
Hester, W. J.	S. and C. E.,	Cambridge,	Guernsey.
Hill, G.	Civil Engineer,	Milford,	Clermont.
**Hiller, J.*	Civil Engineer,	Dayton,	Montgomery.
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*Hoge, O. S.	Co. Surv'r and C. C. E.,	Cambridge,	Guernsey.
Holden, L. E.	Civil Engineer,	Cleveland,	Cuyahoga.
Holl, J. H.	Civil Engineer,	Canton,	Stark.
*Holl, O. W.	County Surveyor,	Canton,	Stark.
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*Hollister, J. J.	Surveyor,	Dunham,	Washington.
Hoover, O. H.	Co. Surv'r and C. E.,	New Philadelphia,	Tuscarawas.
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Hopkins, W. W.	Surveyor,	Cherry Valley,	Ashtabula.
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Hosbrook, J. A.	Dep. County Surveyor,	Cincinnati,	Hamilton.
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These paving brick have ceased to be an experiment, have been in use for eight years, and the demand is steadily increasing. Are now extensively used in Philadelphia, Pa., Cleveland, O., Memphis, Tenn., Wheeling W. Va., Trenton, N. J., Washington, D. C., Toledo, O., Oil City, Pa., and in many other smaller cities and towns. Correspondence solicited. Sample brick sent to responsible parties, free. Splendid facilities for shipping by rail or Ohio river.

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le, J. D.	Dep. County Surveyor,	Ottawa,	Putnam.
n, D. P.	S. and C. E.,	Napoleon,	Henry.
ian, A. S. W.	Assistant C. C. E.,	Columbus,	Franklin.
i, A. V.	County Surveyor,	Bentonville,	Adams.
rt, J. P.	C. C. E.,	Marietta,	Washington.
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ireys, J. S.	S. and C. C. E.,	Findlay,	Hancock.
gton, E.	Surveyor,	Painesville,	Lake.
, S.	County Surveyor,	Steubenville,	Jefferson.
G. A.	Civil Engineer,	Cleveland,	Cuyahoga.
G. S.	Civil Engineer,	Columbus,	Franklin.
l, J.	S. and C. E.,	Morrow,	Warren.
W. C.	Consulting Eng. C. C. C. & St. L. Ry.	Cleveland,	Cuyahoga.
n. W. J.	C. C. E.,	Piqua,	Miami.
J.	County Surveyor,	Cadiz,	Harrison.
, L. C.	Civil Engineer.	Zaleski,	Vinton.
, F. B.	Civil Engineer,	Uhrichsville,	Tuscarawas.
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n, W. J.	Surveyor,	Payne,	Paulding.
n, A.	Surveyor,	Paint Valley,	Holmes.
, W. H.	Surveyor,	Washington C. H.,	Fayette.
Prof. J. N.	S. and C. E.,	Rio Grande,	Gallia.
E. C.	Surveyor,	Jackson,	Jackson.
W. C.	Civil Engineer,	Cleveland,	Cuyahoga.
W. B.	Civil Engineer.	Van Wert,	Van Wert.
L.	Surveyor,	Buena Vista,	Scioto.
, W. S.	County Surveyor,	Woodsfield,	Morrow.
P. N.	Civil Engineer,	Cincinnati,	Hamilton.
, C. A.	C. C. E.,	Sandusky,	Erie.
, A. W.	S. and C. E.,	Sandusky,	Erie.
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er, W. R.	Civil Engineer,	Lebanon,	Warren.
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am, G. H.	Civil Engineer,	Toledo,	Lucas.
all, G. H.	Ch. Eng. L. S. & M. S. R. R.,	Cleveland,	Cuyahoga.

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*Legg, E. E.	S. and C. E.,	Columbus,	Franklin.
*Lesher, G. W.	County Surveyor,	Fremont,	Sandusky.
*Lewis, G. W.	Civil Engineer,	Cincinnati,	Hamilton.
Lewis, L.	Mining Engineer,	Jackson,	Jackson.
Lewis, C. F.	Civil Engineer,	Cleveland,	Cuyahoga.
Liggett, W. K.	Chief Eng. Iron Substructure Company.	Columbus,	Franklin.
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*Linton, W. H.	Sup't W. W. and C. E.,	Ravenna,	Portage.

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*Lovett, T. D.	Civil Engineer,	Cincinnati,	Hamilton.
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*Mackey, C. L.	S. and C. E.,	Youngstown,	Mahoning.
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Marble, R. R.	C. C. E.,	Canton,	Stark.
Markley, P.	Civil Engineer,	Wooster,	Wayne.
Martin, C. V.	Civil Engineer,	Zanesville,	Muskingum.
Masters, G. A.	Civil Engineer,	Toledo,	Lucas.
Matheny, W. F.	Civil Engineer,	Mineral Springs,	Adams.
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*Miller, E. M.	S. and C. E.,	Greenville,	Darke.
Miller, D. A.	C. C. E.,	Massillon,	Stark.
*Miller, J. R.	Civil Engineers,	Toledo,	Lucas.
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*Moler, J. D. and W. S.	Civil Engineer,	Springfield,	Clarke.
Moody, P.	Mining Engineer,	Armadale,	Athens.
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Paul, Ed.	Civil Engineer,	Cuyahoga Falls,	Summit.
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Peters, W. E.	Civil Engineer,	Athens,	Athens.
Pettee, F. W.	S. and C. E.,	Akron,	Summit.
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*Plumer, J. A.	Civil Engineer,	Marietta,	Washington.
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*Reed, H. B.	Civil Engineer,	Canton,	Stark.
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Reid, A. L.	Surveyor,	Eaton,	Preble.
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Reynolds, C.	S. and C. E.,	Peeble,	Adams.
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Riggs, M. J.	B. C. E.,	Toledo,	Lucas.
Riggs, H. E.	Ch.Eng.T.A.A. & N.M.Ry.,	Toledo,	Lucas.
Robinson, H. H.	Surveyor,	Millersburg,	Holmes.
Robinson, M. S., Jr.	Civil Engineer,	Cleveland,	Cuyahoga.
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Sager, N. A.	Civil Engineer,	Bucyrus,	Crawford.
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Saunders, C. L.	Civil Engineer,	Cleveland,	Cuyahoga.
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Sill, J. S.	Co. Surv'r and C. E.,	Ashtabula,	Ashtabula.

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S. and C. E.,	Findlay,	Hardin.
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Surveyor,	Otway,	Scioto.
County Surveyor,	Elyria,	Lorain
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Civil Engineer,	Columbus,	Franklin.
S. and C. E.,	Perrysburg,	Wood
Civil Engineer,	New Lisbon,	Columbiana.
Civil Engineer,	Cincinnati,	Hamilton.
Pres. Case School of Applied Science	Cleveland,	Cuyahoga.
Civil Engineer,	Dayton,	Montgomery.
Co. Surv'r and C. E.,	Defiance,	Defiance.
Surveyor,	Leesburg,	Higland
S. and C. E.,	Raysville,	Vinton
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S. and C. E.,	Shelby,	Richland.
Civil Engineer,	Shyville,	Pike.
Civil Engineer,	Granville Junc.,	Licking.
S. and C. E.,	Toledo.	Lucas.
S. and C. E.,	Salem,	Columbiana
Surveyor,	Findlay,	Hancock.
Civil Engineer,	Cleveland,	Cuyahoga.
Surveyor,	Gustavus,	Trumbull
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S. and C. E.,	Akron,	Summit.
Co. Surv'r and C. C. E.,	Urbana,	Champaign
S. and C. E.,	Ottawa,	Putnam.
Civil Engineer,	Toledo,	Lucas.
Civil Engineer,	Toledo,	Lucas.
Consulting Engineer,	Cincinnati,	Hamilton
Mining Engineer,	Trimble,	Athens.
Civil Engineer,	Cleveland,	Cuyahoga.
S. and C. E.,	Stouts,	Adams.
Ass't C. C. E.,	Akron,	Summit.
Civil Engineer,	Cincinnati,	Hamilton
Civil Engineer,	Cleveland.	Cuyahoga.

Civil Engineer,	Mt. Vernon,	Knox.
Civil Engineer,	Cincinnati,	Hamilton.
Surveyor,	Warren,	Trumbull.
Civil Engineer,	Lima,	Allen.
Vice Pres. Z. H. & C. Ry.,	Zanesville,	Muskingum.
Civil Engineer,	Dayton,	Montgomery.
Surveyor,	Warren,	Trumbull.
Surveyor,	Kinsman,	Trumbull.
Civil Engineer,	Nelsonville,	Athens.
Surveyor,	Marysville,	Union.
S. and C. E.,	Cleveland,	Cuyahoga.
H. Ch. Eng. N. Y. P. & O. Ry.,	Cleveland,	Cuyahoga.
S. and C. E.,	Lancaster,	Fairfield.
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Co. Surv'r andC. C. E.,	Troy,	Miami.
Civil Engineer,	Cleveland,	Cuyahoga.
Co. Surv'r and C. E.,	Chillicothe,	Ross.
County Surveyor,	McArthur,	Vinton.
S. and C. E.,	Dayton,	Montgomery.
County Surveyor,	Wapakoneta,	Auglaize.
Co. Surv'r and C. C. E.,	Pomeroy,	Meigs.
Co. Surv'r and C. C. E.,	Hamilton,	Butler.
County Engineer,	Newark City,	Licking.
C. C. E.,	Bucyrus,	Crawford.
S. and C. E.,	Galion,	Crawford.
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Surveyor,	New Philadelphia,	Tuscarawas.
Surveyor,	Bowling Green,	Wood.
S. and C. E.,	Gallipolis,	Gallia.
Co. Surv'r and C. E.,	Mineral Ridge,	Trumbull.
Sup't and C. E. of W. W.,	Cleveland,	Cuyahoga.
C. C. E.,	Pickaway,	Miami.
Dep. Co. Surveyor,	Montville,	Geauga.
Civil Engineer,	Toledo,	Lucas.
S. and C. E.,	Defiance,	Defiance.
S. and C. E.,	Massillon,	Stark.
Co. Surv'r and C. E.,	Toledo,	Lucas.
Civil Engineer,	Cleveland,	Cuyahoga.
Surveyor,	Parkman,	Geauga.
Ch. Eng. D. H. V. & E. Ry.,	Columbus,	Franklin.
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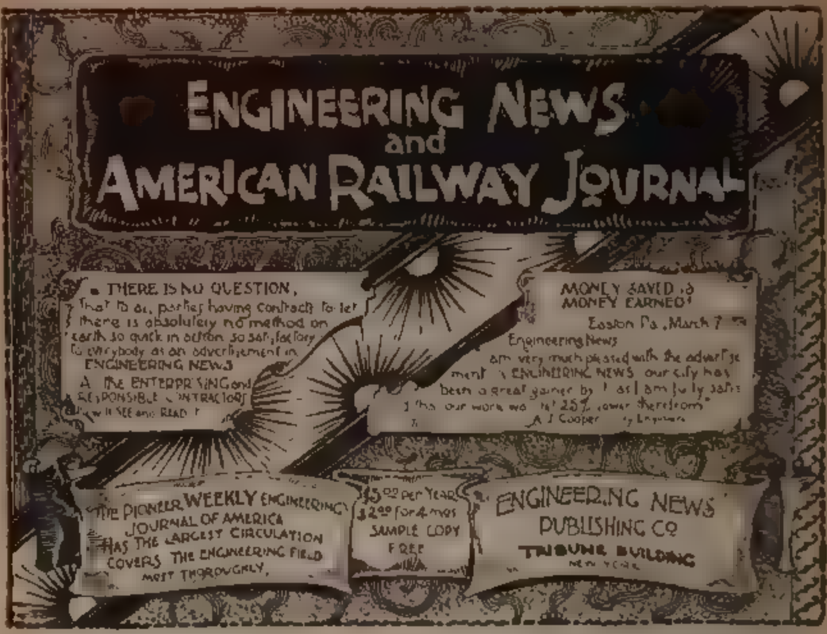
*Wilson, J. F.	Ch. Clerk Ch. Eng. Office C. N. O. & T. P. Ry	Cincinnati,	Hamilton.
*Wise, D. M.	Civil Engineer,	Girard,	Trumbull.
*Wise, C.	Surveyor,	Canton,	Stark.
*Wolverton, I. M.	Civil Engineer,	Cleveland,	Cuyahoga.
*Wonders, J. C.	County Surveyor,	Bellefontaine,	Logan.
*Wood, C.	Acting Chief Eng. C. H. & D. R. R.	Cincinnati,	Hamilton.
Wood, J	Surveyor,	Tiffin,	Seneca.
Wood, W. H.	County Surveyor,	Bowling Green,	Wood.
Woodling, A.	Surveyor,	Beach City,	Tuscarawas.
*Woodbridge, F.	Eng. M. of W. Sandusky Div. C. C. & I. Ry.	Sandusky,	Erie.
Wright, J. R.	Surveyor,	Mt. Oreb,	Brown.
Wulfukeotter, E. W.	Civil Engineer,	Cincinnati,	Hamilton.
*Wyllyaumez, M. B.	Civil Engineer,	Toledo,	Lucas.



✣ Sager's ✣ Patent ✣ Chain ✣ Tapes. ✣

These Tapes are made to take the place of Surveyors' and Engineers' Chains.

Unlike ordinary tapes, they are detached from the reels on which they are carried, and when in use each end of the line is provided with convenient detachable handles. They are marked to either feet or links, and are made to any desired length. They are found superior to chains in the following points:

They never get longer by use.
Much lighter and easier to handle.
Have guards for setting the marking pins.
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Index of Back Numbers.

FIRST ANNUAL REPORT, 1880. PRICE 26 CENTS.

Organization, January 15-16-17, 1880.
Report of Committee on County Work and Official Duties, comprising:
Preservation of Land Records.
Concerning Road Surveys and Base Lines.
Inequalities of Fees.
Concerning a Standard of Qualification.
Outlines of a Plan to Provide for the Commission of a Corps of Ohio Land Surveyors.
Report of Committee on Statutes in Force and Fees.
Queries Answered by Secretary of State and Attorney General.

SECOND ANNUAL REPORT, 1881. PRICE 26 CENTS.

Decision of Attorney General Pillars on Mileage.
Ohio's Civil Boundaries, Past, Present and Future, F. J. Sager.
House Bill No. 494, relating to County Surveyors' Duties.
Bills to be presented:
Concerning a Standard of Qualifications.
For the Preservation of Land Corners.
Partial List of Land Surveyors of the State of Ohio.

THIRD ANNUAL REPORT, 1882. PRICE 27 CENTS,

Questions in Practice with Answers.
To Establish a Meridian Line, Prof. R. W. McFarland.
Land Surveying and Its Phases, F. M. Davisson.
Magnetism and Magnetic Variation, Jonathan Arnett.
The Office of County Surveyor, Fred Howell.
Bridges, B. F. Bowen.
Constitution and By-Laws.
List of Members.
Index to Revised Statutes, with Special Reference to a Surveyor's Duties.

FOURTH ANNUAL REPORT, 1883. PRICE 27 CENTS.

Reorganization, with Constitution and By-Laws.
History of the Office of County Surveyor in Ohio, R, S. Paul.
Improved Roads, S. A. Buchanan.
Tenure of Land in Ancient Times, R. W. McFarland.
Sanitary Engineering, J. B. Strawn.

The Surveyor and Engineer's Mission, Jonathan Arnett.
List of Engineers in Ohio.

FIFTH ANNUAL REPORT, 1884. PRICE 55 CENTS.

Reports of Committees, very full, especially as to Ditches and Manual.
Address by G. H. Frost.
Origin of the Rectangular System of Surveying, Chas. Whittlesey.
Special Applications in Sanitary Engineering, J. B. Strawn.
Magnetic Declination with Observations in Ohio and Elsewhere, Benjamin Thompson.
Peculiarities of Declination, W. H. Jennings.
Land Drainage, D. W. Pampel.
Field Notes, Their Record and Preservation, R. S. Weitzell.
Surveying Instruments and Their Uses, Francis M. Priest.
Land Surveying, J. D. Varney.
Iron Bridge Connections, John Harvey.
Standards of Measure, T. C. Mendenhall.

SIXTH ANNUAL REPORT, 1885. PRICE 56 CENTS.

President's Address. J. B. Strawn.
Incorporation—Discussion.
Manual of Surveying, F. Hodgman.
Plate Girder Bridges, —— Becker.
Transmission of Power, R. F. Hartford.
Report of Drainage Committee, E. D. Shreve, Chairman.
The Problem of Just Apportionment of the Cost of Ditch Improvements, E. B. Opdyke.
Principles Involved in Making Ditch Estimates and Assessments, J. L. Geyer.
Report of Committee on Land Surveying, J. D. Varney, Chairman.
The Solar Compass in Land Surveys, Geo. R. Gyger.
Report of Committee on Blanks and Instruments, F. M. Priest, Chairman.
The Surveyor and His Field Notes, John L. Culley.
Descriptions in Deeds, R. S. Weitzell.
Sanitary Arrangements in Out Buildings at Mt. Gilead, O., B. J. Ashley.
Report of Committee on Civil Engineering, J. H. Holl, Chairman.
Report of Committee on Highways, F. M. Davisson, Chairman.
Charter, Constitution and By-Laws.

INDEX TO BACK NUMBERS.

SEVENTH ANNUAL REPORT, 1886. PRICE 58 CENTS.

EIGHTH ANNUAL REPORT, 1887. PRICE 58 CENTS.

INDEX TO BACK NUMBERS.

NINTH ANNUAL REPORT, 1888. PRICE 58 CENTS

INDEX TO BACK NUMBERS.

TENTH ANNUAL REPORT, 1889. PRICE 58 CENTS.

Maps for the Use of Assessors; Report of a Committee and Discussion.
Report of Committee on Land Surveying, J. B. Strawn, Chairman.
The Importance of Properly Making Surveys, Homer C. White.
Water Supply, C. A. Judson.
Bridge Engineering During 1888, A. J. Lewis.
Municipal Engineering, Thomas R. Wickenden.
Street Pavements, Sam. Huston.
Limes and Cements of Ohio, Dr. Orton.
Pile Protection, J. A. Pritchard.
A Curved Dam, ———
Country Parks and Cemeteries, John L. Culley.
Water Supply Difficulties, H. F. Dunham.
Description of a Sewer, H. L. Weber.
Mote Ditch, F. M. Davisson.

ELEVENTH ANNUAL REPORT, 1890. PRICE 58 CENTS.

County Surveyors and the Law Under Which They Work, W. E. Peters.
Condition and Needs of the Engineering Profession in Ohio, Samuel Bachtell.
The Operations of the Coast and Geodetic Survey, Prof. T. C. Mendenhall, Washington, D. C.
Water Works for Towns and Villages, J. B. Strawn.
Rural Water Supply, Its Conditions and Needs, J. Arnett.
Natural Gas, H. L. Weber,
City Streets, How to Build Them and Why, L. W. Mathewson.
The Attempt to Build the First Free Turnpike in Tuscarawas County, W. M. Ray.
Maintenance of Way on Railroads, A. W. Jones.

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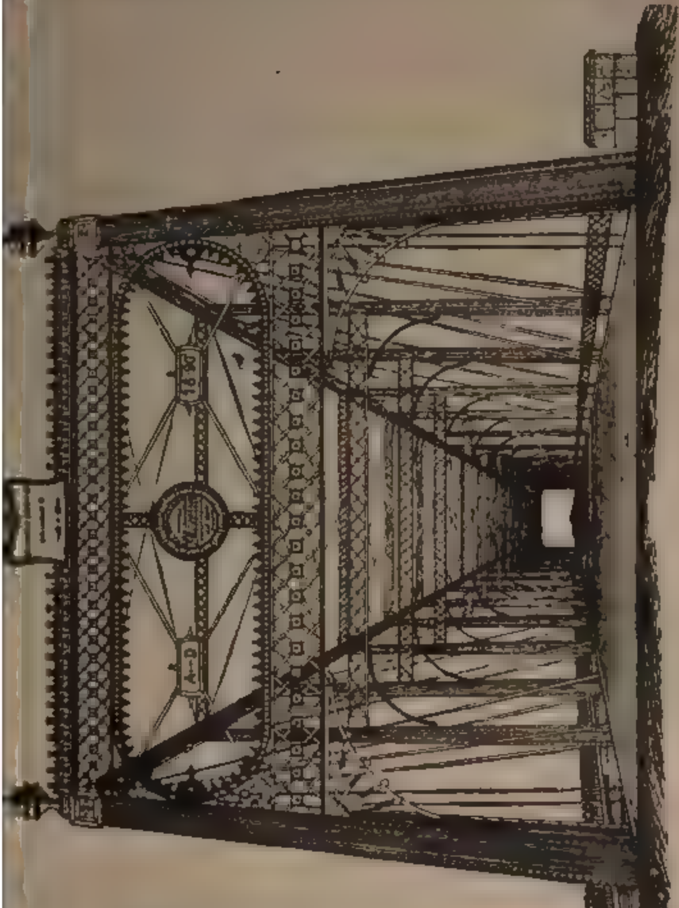

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(XLVII.)

INDEX.

Index to Advertisers.


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OF THE

OHIO SOCIETY

OF

Surveyors and Civil Engineers,

BEING THE

TRANSACTIONS OF THE SOCIETY,

AT ITS

THIRTEENTH ANNUAL MEETING,

HELD IN

Columbus, Ohio, January 19, 20 and 21, 1892.

PRICE, 50 CENTS.

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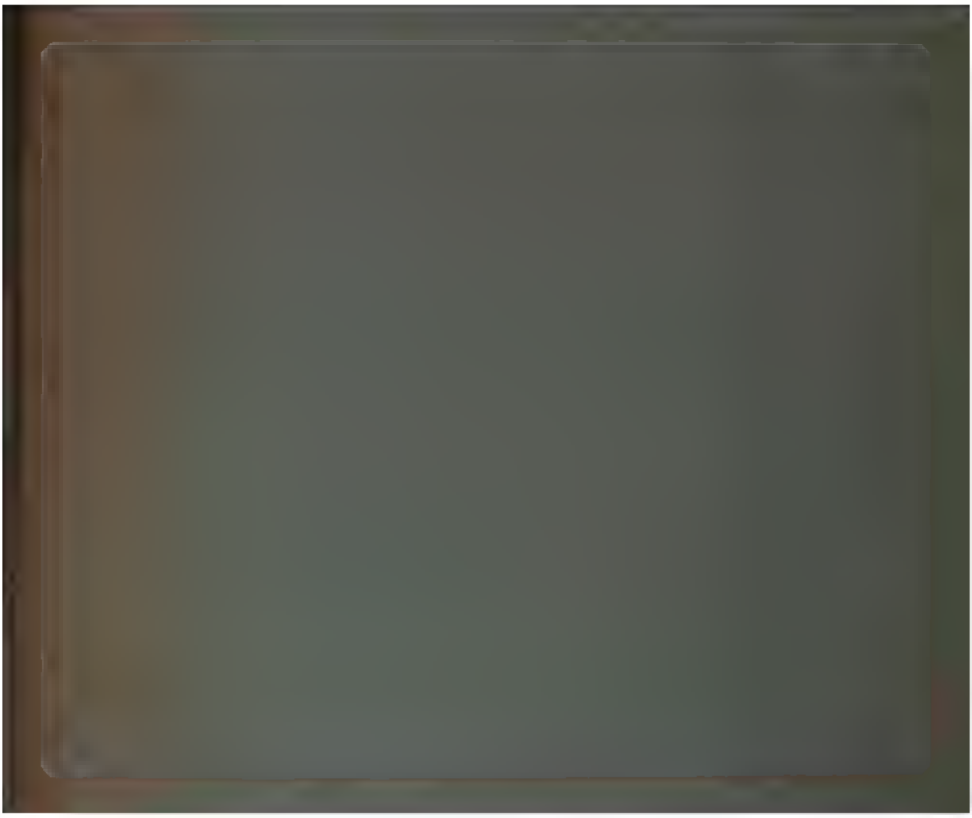

THIRTEENTH ANNUAL REPORT

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Held in Columbus, Ohio, January 19th, 20th and 21st, 1892.

PRICE, 50 CENTS.

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Walker, R. F	County Surveyor and City Civ. Eng.	Troy, Miami Co.
Walker, R. H	County Surveyor	Chillicothe, Ross Co.

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Weddell, J. B.	City Civil Engineer	Galion, Crawford Co.
Weitzell, R. S.	Civil and Mining Engineer	Weatherford, Purker Co., Tex.
White, Homer C.	County Surveyor	Warren, Trumbull Co.
Wickenden, Thos. R.	City Civil Engineer	Toledo, Lucas Co.
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Wilhelm, Henry W.	County Surveyor	Toledo, Lucas Co.

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John Graham		Columbus, Franklin Co.
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Dr. Edward Orton	State Geologist and Pres. O. S. U.	Columbus, Franklin Co.

THE OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS, as a body, is not responsible for the statements and opinions advanced in any of the papers published in this report.

INDEX.

13TH ANNUAL REPORT

—OF THE—

OHIO SOCIETY OF SURVEYORS

—AND—

CIVIL ENGINEERS.

Meetings held in Celtic Hall, Corner of Chestnut & Fourth Streets, Columbus.

OUTLINE OF PROCEEDINGS.

Tuesday, January 19th.

AFTERNOON SESSION.

The society was called to order by President Thos. R. Wickenden, who introduced, in a few words, the business to be transacted, and announced that the reading of the report of the secretary would be deferred for a time.

The report of the trustees was read and placed on file.

Mr. Wileman presented his report as treasurer, and called attention to the fact that the advertisements in the twelfth annual report more than paid the cost of printing the same.

At this point the trustees submitted the following names for membership in the society: John B. Davis, Hosea Paul, Elmer E. Harvey, Carey S. Pratt, and Henry W. Wilhelm.

On motion they were unanimously elected.

The report of the special committee on bill for licensing surveyors being called for, that committee asked for more time to prepare a report, which was granted.

Secretary Wileman submitted his report, which dwelt upon the necessity of providing for a secretary to give his entire time to the work. This feature of the report was discussed at some length, and on motion of Mr. Dunn, a committee consisting of Mr. Bowen, Mr. Mathewson and the secretary was appointed

to report to the society a plan for carrying out the suggestions of the secretary.

On motion of Mr. Bowen the report of the trustees was "referred back for further consideration."

A paper by E. W. Dimmock, of Ottawa, O., "The Annual Change in the Declination of the Magnetic Needle, Is it a Constant Quantity?" was read by the secretary, and discussed at some length by the society.

The secretary also read a paper entitled "Some Practical Experience in Land Partition," by Samuel F. Rock, of Irvine, Ky.

EVENING SESSION.

T. C. Connar, of Zanesville, presented a paper on "The Muskingum River Bridges," which elicited considerable discussion.

The report of the Committee on Blanks and Instruments was submitted by L. W. Mathewson, chairman, Cincinnati, O.

Wednesday, January 20th.

MORNING SESSION.

Meeting called to order at 8:30 o'clock, President Wickenden in the chair.

John C. Grim read a paper, "The County Surveyor," which was generally discussed.

A paper "Conveyancing," by Wm. E. Peters, of Athens, O., was read by the secretary.

The secretary also read a paper by Homer C. White on the subject "County Ditch Assessments," which was followed by considerable discussion.

At this point Mr. Gurley, of W. & L. E. Gurley, of Troy, N. Y., gave a very interesting informal talk on the manufacture of instruments, and was followed by Mr. Link, representing Keuffel & Esser Co., of New York. Both gentlemen explained

ı detail the improvements made in the instruments manufacıred by their respective firms, and which were shown in the xhibits made by them at the meeting.

At this point President Wickenden delivered his annual adress.

A communication was received from the Columbus Sewer 'ipe Company inviting the members to visit their works at North Columbus. On motion the invitation was accepted.

The following telegram was received:

GRAND RAPIDS, MICHIGAN.

ecretary of the Ohio Society of Engineers and Surveyors:

The Michigan Society sends its most hearty greeting.

F. HODGMAN, *Secretary.*

On motion of Mr. Innis the secretary was directed to make proper response.

At this point the secretary read a proposed bill, drafted by Mr. Geo. H. Hill, defining what shall constitute a legal description of land.

The question of a permanent secretary was again called up, nd in the discussion which followed it was incidentally stated hat the society had a small library, consisting principally of exhanges from the Franklin Institute, the Smithsonian Institute, ournal of the American Society, etc.

C. H. Burgess, chairman of the special committee, submited a bill prepared by that committee relating to the licensing of urveyors.

AFTERNOON SESSION.

The trustees reported the following names for membership ı the society: E. L. Spafford, Chas. B. Fidlar, H. W. McDonld, John B. Davis, and Daniel A. Muller.

On motion they were unanimously elected.

J. T. Buck, Chairman, then presented the report of the Comnittee on Surveying, which was followed by some discussion.

This was followed by a paper, "Record of Surveys," by D. W. Seitz.

Geo. McGormley read a paper on "Platting of Town Lots."

At this point the president appointed a Committee on Nominations, consisting of Messrs. Strawn, Grim and Burgess.

The society then proceeded to consider the bill submitted by the special committee.

After nine sections of the bill had been considered, discussion was suspended.

At this point the special committee on plan for permanent secretary made its report.

EVENING SESSION.

The society proceeded to the further consideration of the bill.

After the discussion was concluded, the bill, as amended, was, on motion of Mr. Strawn, referred back to the original committee to be rewritten and again presented.

Then followed a discussion of the report of the committee on permanent secretary. After some debate, on motion of Mr. Connar, it was referred back to the committee.

A resolution of sympathy with Prof. Orton, in the serious illness which prevented him from attending the sessions, was, on motion of Mr. Strawn, adopted.

Prof. Brown stated some of the difficulties encountered by himself in making cement tests.

Thursday, January 21st.

MORNING SESSION.

President Wickenden in the chair.

The trustees submitted a suplementary report fixing the assessment for 1892 at five dollars.

The report of the Committee on Highways was read by the president.

Mr. Graham addressed the society on "The Surveys of the

Boundary Line between Ohio and Indiana and between Ohio and Michigan." Discussion.

Papers: "Width of City Streets," by Samuel Whinnery, and "Brick Pavements," by H. L. Webber, were read by title.

Geo. H. Hill submitted "Specifications for Turnpikes," accompanied by plans for their construction.

By vote of the society the Technograph of the Illinois State University was placed on the list of exchanges of annual reports.

At this point the secretary read a telegram from Wilber A. Ginn.

The report of the Committee on Resolutions followed.

By vote of the society the secretary was directed to make drafts on all members who were more than thirteen months in arrears for annual dues.

A paper: "Improvement of County Roads," by G. S. Innis, was read by title.

The trustees recommended for membership H. F. Alkire, B. H. Walker and Chas. E. DeWitt.

On motion they were elected.

B. F. Bowen read a paper on the "Sewerage of Pullman, Ill."

J. B. Strawn submitted a report on the "Test Case."

F. M. Davisson, Chairman, presented the report of the Committee on Drainage.

AFTERNOON SESSION.

J. B. Strawn, chairman, submitted the report of the Committee on Civil Engineering.

At this time the special committee, to which had been referred the bill, reported the same as amended and revised.

On motion of Prof. Brown the bill was indorsed by the society.

On motion of Secretary Wileman it was referred to a special committee of three to secure its passage through the legislature.

The president appointed on this committee C. H. Burgess, B. F. Bowen, and L. W. Mathewson. Appointment approved by vote.

The Committee on Nominations recommended the following gentlemen for officers during the ensuing year: For President, C. H. Burgess; for Vice-President, L. W. Mathewson; for Secrerary and Treasurer, Chas. A. Judson; for Trustees, G. S. Innis, Julian Griggs, F. M. Kennedy, W. H. Gaffney, and J. T. Buck.

On motion of Mr. Connar they were unanimously elected.

Paper: "Details of Ditch Location," by A. D. Sheldon, was, on motion of Mr. Sheldon, read by title.

The trustees having recommended Mr. H. M. Gates for membership, he was, on motion of Mr. Strawn, elected.

L. W. Mathewson, chairman, presented the report of the Committee on Blanks and Instruments.

The report of Mr. Strawn on the "Test Case" coming on for disposition, on motion of Mr. Mathewson, the sum of $80.00 was voted to Mr. Strawn toward expenses of conducting the suit. Mr. Strawn agreeing to pay the balance himself.

By vote of the society Mr. Wileman was allowed $200.00 for his services as secretary during the past year, and the salary of the secretary for 1892 was fixed at $200.00

A paper by H. W. McDonald, "Sewer Systems," was read by title.

Thereupon, after a few words from the president the thirteenth annual meeting was adjourned.

PRESIDENT'S ADDRESS.

THOS. R. WICKENDEN, TOLEDO, OHIO.

Gentlemen of the Ohio Society of Surveyors and Civil Engineers:

FELLOW WORKERS:—It is with much pleasure that I greet you all on this the occasion of our thirteenth annual meeting.

Coming, as I trust we all do, from prosperous and successful years of labor, and judging from the present indications, we are warranted in believing that this meeting shall not only be equal to, but also better than any that have preceded it.

The fact that this is the thirteenth annual meeting shows us that the society has gone beyond any experimental stage; it is now an established fact; a permanent institution having a history, and whose standing in its special field of labor is such that I count it an honor to be numbered among its membership.

That the society has been beneficial and useful none can question. The bringing together at its annual meetings of so many whose labor and aims are in the same direction, must broaden our views and better fit us for our work. While the annual publication of the proceedings of the society forms a valuable and ever increasing library to each volume of which the comment of one of our leading engineering journals on our last publication, to the effect that "since the discussion and papers being almost entirely by men in active practice, there are many points of a practical nature in this pamphlet which it would be difficult to find elsewhere," might very properly be applied.

The reports of the secretary and treasurer show the society to be in a good condition, and the applications for membership presented at this meeting are very encouraging.

But, gentlemen, while we congratulate ourselves on our permanency and usefulness, we must remember that we live in an age of progress, and if the society is to maintain its present standing and continue in the front rank, a place we now certainly occupy, our watchword must be "forward," and we must make it of greater help and usefulness to individual members and through them to the profession and society at large.

It is my purpose to express my views and feelings as to how these ends can be obtained.

The discussion of means for obtaining this very desirable end will form one of the principal features of the meeting, and it is expected that every member will feel free to express his views on the matters under discussion and offer such suggestions, and, if necessary, criticisms, as will lead to results that are best, so that when we go before the public with our requests we may be able to show the justice and desirability of the same, as only in this way can we hope for success.

The suggestions which we may send to the State legislature should be the best that can possibly be offered, backed by sound argument and common sense, and when these suggestions are presented we must remember that our work is but begun, and that we hope to win success only by wise and persistent effort. We must remember that our worthy legislators are crowded with bills affecting both public and private interests, all of which are being pushed by energetic and interested men, making it necessary that the full influence of our entire membership shall be brought to bear on every point available, and requiring the special push and energy of the committee to whom this matter shall be intrusted.

The secretary has brought to our notice certain suggestions as to the future work and welfare of the society, especially with a view of widening the scope of our work, and making the society of more practical use to its individual members. These suggestions in the main meet the approval of a number of the officers of the society, but they should be fully and freely discussed and well considered before final action is taken on them.

When we have discussed and acted on the various suggestions offered and advanced, we must still remember that, above all other men, the surveyor and engineer is known by his works, and the permanent advancement of the profession can only be attained by the individual effort of each person engaged therein.

Our position in society is both peculiar and unique. I know of no other class of men who are placed in such peculiar relation as the engineer and surveyor. Though without any legal recognition in this state, except such that might be used to make honest error take the nature of crime, we often find ourselves occupying the position of attorney, judge and jury combined, being required to gather the evidence, review the same and decide therefrom matters of great importance both to the individual and the community, and at times our decisions must appear to be against the personal interests of our client, to whom we look for our compensation. Then in the conduct of public work; where can we find such another combination as the engineer who de-

signs, superintends, and estimates the amount of compensation to be paid under the contract? First, he must prepare proper plans and specifications; when bids are submitted determine who is the lowest bidder; after the contract has been duly executed he is often the only intelligent representative of the people, who are one of the parties to the contract. He must demand and insist by all means known to him that the work be executed in accordance with the spirit of the contract. It is also necessary that arbitrary power be placed in his hands as judge of material and work, yet he must deal justly with the contractor, even though strong influences might be brought to urge him to overstep the line of absolute justice.

I am fully aware that the contractor is usually well able to take care of himself, and also that he of all men quickly realizes when the line of strict justice is overstepped and is usually ready to take advantage and resent any excess in the use of his powers that the engineer may assume. These facts make the position of the engineer both complicated and difficult. The man to fill such a position must be a good man, of superior mental qualities, and he ought to have a standing before the law commensurate with the importance of his position and work. An attorney at law, who can take care of the interests of but one side of any question or case he may be employed on, and must try his case before an impartial judge, is required to give evidence to competent judges of his fitness for such work before entering on his business career. In the matter of surveying and civil engineering, however, any man, no matter how ignorant he may be of the work he seeks, can set himself up in business as a land surveyor or civil engineer, provided he can find some person foolish enough to engage his services, with nothing to prevent or hinder him from so doing. Such examples may not be very frequent, yet I doubt not that among this company there are many who have met some such person, and we all know that the result is only disgrace to the profession and damage, annoyance and expense to whoever may be affected by the work of such parties. These things being so indicate the necessity of combined and persistent effort on our part to secure just and efficient laws to remedy the defects.

The interests entrusted to the surveyor and civil engineer are surely of sufficient importance to justify the State of Ohio in requiring those who assume to undertake such responsibilities to give evidence of their ability to do such work.

While we respectfully and firmly demand and insist that our rights in these matters be granted, let us do so with a proper

appreciation of the importance of our position. I would not advise or encourage an improper egotism on the part of either individuals or organized bodies of men. Yet we cannot expect the public to think better of us than we think of ourselves, any more than we can expect appreciation and recognition without actual ability and worth. For these reasons I urge that in doing the work for which we are especially organized, viz:—"the greatest advancement of the interests of our profession," we remember the importance of our relations to the public at large, and the necessity of maintaining a high standard of work, and the ever watchful care that the dignity of our profession be fully maintained by proper firmness and scrupulous honesty in dealing with all parties whose interests are entrusted to our care; we can then boldly and fearlessly demand our rights and expect our persistent efforts to be crowned with success.

There is another duty which the older and established men owe to the profession—one which should not be neglected—that is, we should impress young men starting out in the work, that only by such means as have here been suggested can they look for preferment and success in their work.

Gentlemen, we are an organized body made up of individual units, and the success of the whole must directly or indirectly mean the success of the unit. It is therefore to our individual interest to work for the success of the whole. And yet the position of some may be such that they can see no direct benefit to arise to them from the measures and extended plans of work that may be evolved by this meeting, and, holding such views, such persons might conclude that it is wise conservatism, either to favor the negative side of the questions proposed or neglect to use their personal influence for their furtherance and success. I trust that none entertain such views or feelings, and hope and urge that all may rise above the plane of working alone for personal benefits, and that we may present a united and strong front, each working earnestly for the best interests of the whole.

There is another matter I deem worthy of our attention, and some might consider it presumption, that a criticism be made at this time and place. I refer to the injurious practice we sometimes meet in cutting prices for private or public work to a point below what is actually a fair remuneration for service rendered. To my mind this is the height of folly. There is a certain amount of work to be done, and a definite number of men to do it, and proper and just prices for good work should be maintained. Organizations should use their strongest influence to promote this end, and individuals who persist in this pernicious prac-

tice should be discouraged and condemned, and all honorable means known should be used to bring about a reform in this matter wherever it is needed.

The growth of our society until it shall at least include among its members all honorable men practicing the several branches of our profession within the boundaries of Ohio, is an end we should earnestly desire and work for. Therefore let us make the Society and its methods so attractive and efficient that the many now engaged in the work and outside our society shall be drawn to its associations as if by force of gravity.

Gentlemen, allow me to observe in closing that your President is fully aware that these remarks contain nothing of scientific value, but with the hope that there may be found therein some practical suggestions which shall lead to profitable discussion, united action and beneficial results, they are most respectfully submitted.

THE COUNTY SURVEYOR.

JOHN C. GRIM, BRYAN, O.

The Statute Laws of the State of Ohio provide for the election of a County Surveyor in each county every three years, but under the present law it is not a desirable position to fill.

Surveyors are forced to recognize the fact that year after year it is becoming more difficult to do land surveying. The land was first surveyed by the government, and as long as the marks of that survey remain we have but little trouble.

Our system of land surveying is good as far as it goes, but it does not go far enough. The government does its share of the work, and well, when we consider the difficulties in the way when the work was done in this State.

After the surveys were made the land was taken up by settlers, roads were constructed, towns and cities sprang up, and now at the end of a century we are a rich and powerful State.

But in all this time what has been done by this state to preserve and perpetuate the marks and monuments left by the government, and which were of the greatest value? Nothing. What has been done by the counties? Nothing, almost. What has been done by the people as individuals? All that has been performed for better or worse.

But that, when taken as a whole, has been very unsatisfactory. Some persons are careful, intelligent, and industrious. Such per-

sons would probably look carefully after their corners and have them properly marked and recorded. Others are careless, ignorant, and indolent. Such persons would be sure to do nothing of the kind, and so after years of neglect many are lost.

The preservation of that survey should have been attended to by the several counties, and the work of replacing marks and monuments should have been performed in a systematic way.

Instead of this the county surveyor records only his own work. Much of the work being done by other surveyors there is no public record kept of it, and we find corners everywhere with nothing to show how or by whom they were placed.

Some have been placed by good surveyors and are found to be correct.

Others have been placed according to methods which are past finding out.

But in looking over the county surveyor's records we find that here, as well as elsewhere, there are methods past finding out. It is unnecessary to give any examples of the same, as every practical surveyor knows only too well of what they would consist. Also to be fully appreciated they must be found in actual practice. The greater part of the surveys recorded are of no use whatever, because the useful part is left out, or, if the survey is composed of only what is shown on the record, it was of no consequence when made.

The county pays nothing for recording the surveys, and the persons having work done think the marks left on the ground are sufficient. Consequently the surveyor gets but little for his work in that line and gives the same in return.

Surveys when properly recorded are of much value, and not only to the individual who wants the survey made, but to the public in general. The public should therefore pay a part of the expense, or, in other words, pay for the recording.

This is an age of questioning, investigation, research, and study. Every subject gets its share of comment, nothing escapes.

How often we see the headline "Is Marriage a Failure?" *We* no longer question whether the office of County Surveyor is a failure. We know that it is.

The surveyor himself may not be a failure, but he must have a new system of laws governing the office to make it a success.

In looking back over the efforts made by this Society in the past regarding legislation, it seems useless almost to try farther yet we must not give up.

I hope that the worst is past, and that, from this time on, such laws will be passed as are needed to preserve the existing sur-

veys. Also, we want a law which will allow only such persons as are qualified to practice land surveying,

The present laws require no qualification; consequently many persons are elected and attempt to fill the office who have no technical or practical knowledge of surveying or civil engineering. In this case the people who have work done are the losers, as the person so elected starts out and learns at their expense what he can. He gets his pay for what he does whether it is right or wrong, and so gets on very well, seemingly. But in his trials and experiments in doing work he has laid the foundation for lawsuits, neighborhood quarrels, and endless trouble for his successors in office or whoever has to follow after him.

The county surveyor, and all others as well, should have a thorough knowledge of mathematics, though there are many problems in surveying which are not mathematical ones, but require good judgment, study, practice, and experience on the part of the person who would solve them.

Next, he should have good instruments and appliances for doing work, and know how to use them.

I have heard men say that all they wanted for doing office work was a ruling pen, T square, and drawing board, and they could do anything required; while in the field the more delapidated the compass or transit and old link chains the louder the praises in their favor as to what they had done and what they could do with them.

While it is sometimes possible to do work with such an outfit, it is not profitable either financially or otherwise.

County surveyors sometimes want the county commissioners to buy a good field outfit for them, consisting of transit, level, rod, tapes, etc., which I think would be a great mistake. The man who is qualified and intends to follow surveying and civil engineering for a profession should have the necessary instruments and appliances.

The man who is not qualified and becomes the county surveyor would not be a fit subject to receive from the commissioners or his predecessor in office a set of fine field instruments with which to begin his experiments.

Better give him an axe and spade.

With the axe he can cut out of trees old marks or find hollow places which his imagination can easily fill.

With the spade he can dig down into the earth and find the roots of the trees marked, which, in some unaccountable way he can tell to have belonged to some identical tree.

It should be the duty of the county surveyor to record all surveys of land made in his county.

Surveys made by other surveyors should be placed in his hands for record.

The record of county ditches should be kept in his office, and all ditches recorded by him in suitable books, with plat and profile of the same.

The record of roads should be kept by him also.

He should be required to replace, at the expense of the county, all lost section corners, or quarter posts, or those which are in danger of being lost or destroyed. This would be a move in the right direction toward preserving the original surveys, as previously spoken of in this paper.

Let us then try to elevate the office of county surveyor; for by so doing I think we will elevate the standard of surveying and civil engineering in the State of Ohio.

DISCUSSION.

The President—Gentlemen, you have heard the reading of the paper, and discussion on the paper is now in order. No doubt all of us are ready to say, "Those are my sentiments too."

Mr. Mathewson—Is not there a law in force now requiring county Commissioners to pay surveyors for fixing corners and recording surveys?

A member—In our county they do not pay for recording surveys. One great trouble is to enforce the law which we have against commissioners.

Mr. Strawn—I have been seeking for light on this subject for the last seven or eight years, and we finally got a decision in the Supreme Court, and the report was published in the Law Bulletin of last March. The law that was formulated by this Society was evidently all right, but it is just like almost every other bill formulated by persons who have other business. If it gets into the hands of a legislative committee it is nearly always doctored, and ours was doctored so thoroughly that it was practically killed. We supposed that we had a law that would be all right for us, and we also had the assurance of Attorney-General Lawrence that the statute was all right; that the county surveyor should be remunerated for recording of plats, and that in fact the law was mandatory; that he should record all plats of his surveys either official or otherwise. The law was, by the amendments, made somewhat ambiguous. It was held by Attorney-General Lawrence that the law was sufficient, and that all surveys made by county surveyors, or their deputies, should be

recorded; and the Common Pleas Court of Columbiana county held that was correct, and that he should be paid for indexing. The indexing was not questioned in the case of the recording of plats, was not questioned in the Common Pleas Court. The county commissioners appealed the case to the Supreme Court, or to the Circuit Court, and the Circuit Court affirmed the decision of the Common Pleas Court as to the indexing, but reversed it as to the recording of plats. They granted the pay for the indexing, but declined to allow for the recording of plats. The case was carried to the Supreme Court carried up in my name by Judge Ambler, and the Supreme Court decided that the decision of the Circuit Court should be affirmed; that is that the county commissioners were not required to pay for surveys recorded by the county surveyor. And that is the way the case stands to-day

The President—That is unless they deem them of sufficient importance.

Mr. Strawn - They must be submitted to the county commissioners, and by them deemed worthy of preservation. There is nothing in the law that forbids county commissioners from paying for surveys, but the Circuit Court has decided that there is nothing mandatory upon county commissioners in this respect. I will at some time in this meeting have occasion to make a report, as was required at the last meeting. This will be a preface to that report

Mr Arnett Sooner or later there will have to be something done with the lands in our Virginia Military District. It will devolve upon the younger members of this association, and on the surveyors of Ohio, to block out the plans how that shall be done, and they had better take it in hand now. You had better do it than let it be done by those who do not understand the needs of the case. One of three plans will have to be pursued, The first is to ascertain and establish all the lines and corners of the original military surveys. You all know the difficulty attending that. You know that that surveyor does not live to-day that can restake all of the original Virginia Military surveys. He does not live, and I doubt whether the good Lord intends to make one that can. Another method would be to sectionize the Virginia Military District. I will have to diagram this on the board. Another way would be something like this. Our country is all cut up into roads, where they may probably have to remain for the next five hundred years. Now, survey all this land included between these roads here. Let it be measured accurately showing how much of my land falls in there, and how

much of yours falls in there, and call that tract one ; and if my farm falls in there call that farm one, and call your farm two, farm three, farm four, and so on. When my farm is sub-divided call this lot one, etc. The services of the Coast and Geodetic survey corps should be secured to run a system of triangulation over the State of Ohio, as low down as two stations to the county, and home talent should continue this system of triangulation as low down, say, as two to the township, and fill in thereafter in the most accurate way. All land surveys should be connected in some way with these stations.

A Member—I would like to say that the commissioners of our county are very kind towards paying us for recording our plats. At the end of each month I usually present my bill for recording plats and corner stones, and they have always paid for it. Another thing I would like to speak of is the matter of furnishing the county engineer with instruments. I feel as though I would oppose the gentleman in saying that the engineer should furnish his own instruments. I think every engineer should have his own instruments, but I think it is no more than right that the commissioners should furnish the county engineer, as well as they do all other officers, with the instruments to do their work. I would use my own instruments to do my private work, and the public instruments to do the public work.

Mr. Grim—Mr. President, there is one idea in the report read referring to the county surveyor getting his pay. The gentleman says, as I understood him, that he always gets his pay. He is more fortunate than I have been if he always gets his pay for the work done. The county surveyor is at the mercy of those employing him. If they refuse to pay, unless they are worth it, we cannot make them pay, and they can cause you to do a great deal more work sometimes than is really necessary. I have had a little experience in this line. In one case I had to do about two weeks work for a man, and I had to do it all without his deed because he would not let me have it. I had to go to the records to get the deed to do the work. And afterwards he refused to pay me and I had to sue him to get it. My view is that where a county surveyor is called upon to do work officially his costs should be a lien on the land to secure his pay.

Mr. Dunn—Mr. President, I have done some surveying in my life where I would rather have my fees than the land I surveyed, consequently I don't think in all cases that a lien on the land would help the surveyor.

Mr. Connar—The commissioners of Muskingum county will not pay for recording, and they have refused right along to pay it.

Mr. Mathewson—I have not heard anything said as to county commissioners paying for fixing corners. In Hamilton county I understand the county surveyor is fixing permanent corners at all section corners, and that the county commissioners are to pay for it.

Mr. Grim—I have looked up the law a little and I find that the law is that if application is made to the county commissioners to establish a corner, then they can have it replaced; but unless that is done the county surveyor has no authority to go on and perpetuate these corners without authority from the county commissioners.

SOME PRACTICAL EXPERIENCE IN LAND PARTITION.

S. F. ROCK, IRVINE, KY.

Mr. President and Fellow Members of the Ohio Society of Surveyors and Civil Engineers:

On the 24th of December I received a circular from our secretary and treasurer asking for a paper on some subject to be read at our annual meeting in January. This was his second request, and, although very much occupied with bnsiness cares, I concluded to give you a narrative of a late experience in surveying.

Although not at present a resident of Ohio I have a pride in the well-being of our organization, and would gladly see it at the front among its kindred societies.

The R. N. I. & B. R. R., of which we wrote something last year, is at the present time in the throes of dissolution: or, in other words, is under the control of the U. S. Courts, with the probabilities of long litigation and heavy financial losses to its creditors, friends and projectors.

During the past year, owing to the depression in financial centers throughout the land, the failure on the part of the R. R. company to pay several months' wages owed and overdue, and later the entire suspension of their work of construction, our Engineering Department has been disbanded, and the members have scattered to all parts of the country.

Having long depended on engineering and its kindred science, surveying, for the means of living, my shingle was swung to the

breeze at Irvine, Ky., and among other work done during the past summer, was that of dividing, by order of our Common Pleas Court, a tract of mountain and bottom or river land of nearly 900 acres into 22 parts, so that each of 11 heirs or their representatives should have a share of the bottom and one of the mountain or timber land. All the divisions of each class being made equal in value, taking into account utility, water, timber, houses, accessibility, etc.

The commissioners were appointed by the court, one being the surveyor, to divide and allot the land; and, quoting from the order were "directed to go upon the same, and survey and divide into eleven equal parts according to quantity, quality and value."

The method of allotment adopted by the court was the time-honored scriptural plan as given by God to Moses, and recorded in the book of Numbers: "Unto these the land shall be divided by lot, etc." (Thanks for the quotation to J. F. O'Brien, C. E., of Chandale, Ind.)

None of the parties in interest were allowed by the court to be present during the survey and division, nor at the allotment of the lands, but were allowed to be represented at the allotment by their attorneys.

The commissioners were sworn before entering upon their duties, and the surveyor member of the commission was required and authorized to administer an oath to each person engaged by them on the work.

The legal fees were, for surveyor three dollars per diem, for commissioners one dollar and fifty cents, and for chainmen and markers (axemen) one dollar each. The surveyor would not accept the appointment until the parties in interest agreed to pay him at the rate of five dollars per day.

An extremely faulty description of the land was furnished, a sample of which will be given further along.

All measurements had been made by chaining with the surface of the ground up and down hills, and afterwards corrected by deducting a per centage. This per centage is computed by the surveyor from the angle of the slope, which angle is guessed at; with a consequent error, although some instances have come to my knowledge where the *guesses were close.*

This mode of measurement is still in vogue among some of our mountain surveyors and will continue to be used until an increased value of the lands will cause owners to demand and insist on better work.

If proper care were taken in getting the angles of the slope, which constantly change, this method would, of course, give cor-

lts ; but it is far less trouble to make horizontal measur- the first place.

first work done was to carefully run the boundaries of ›m land ; to meander two small streams that pass across centre of the tract, showing from our notes all the por- and that are swampy and totally unfit for cultivation; der the river which bounds one side, ascertaining while is the location of non-productive land along its banks. lly to locate the springs, of which there are several, and the existing and possible modes of ingress and egress. ving been done, a map of the premises was drawn to a 200 feet per inch, and on this a trial division made. This s then taken on the premises by the commissioners and erations noted as were deemed proper. These were af- made on the map, and the plan executed in the field.

next proceeded to run the boundaries of the mountain l here was trouble! What that trouble was may be di- what has been said relative to the measurements, and ng the description furnished for our guidance,—a portion is here inserted.

ginning at a sycamore on the bank of the Kentucky ner to ———, thence north 27½ degrees east to the cliff, ith the cliff to the Adams Spring, thence easterly to the ie ridge dividing the water of Miller's creek and the y river, thence with the top of said divide until it strikes of the 1186 acres, thence with said line until it reaches corner, etc."

dependence for knowing the corners when reached was ıead-chainman who had been given the place by reason ıpposed knowledge of the locality; but we already had to question his knowledge, and this fact, together with itable chiggers and wood-ticks, the chance of stepping lesnake or copperhead, and the intense heat of an Aug- combined to give us a feeling akin to despair. However, ed at the sycamore corner, having previously in our sur- ie bottom found a course that would run the division fence this and the adjoining farm. This line we extended to ff." We then patiently meandered the foot of the "cliff" Adams Spring," a distance of three-fourths of a mile, and *it* to do was the question. Our man "Friday" had fault- ie next corner and could tell nothing about it. The call terly to the top of the ridge (here a quarter of a mile and any direction from north-east to south-east would answer the call. Before starting, the records had been

searched for a more definite description, but without avail. We were non-plussed. By dint of questioning it was discovered that the former owner of the land we were trying to survey had sold a small tract adjoining to a neighbor, and that this easterly line was one of the boundaries of it. Here was a ray of hope. A messenger was dispatched for the deed, or a copy of the description, and before we slept that night, we had the pleasure of knowing that so far as this line was concerned our troubles were at an end, for course, distance and corner were given. From this the corner was readily established the next day. Some of the remaining lines were troublesome owing to the fact that the courses and distances were not always given. In such cases we assumed a course, as indicated by marked trees, until the corners were found, when the true course was calculated and proper corrections made in the field.

The boundary lines having been completed, the survey was balanced and found to be exceedingly close. This was a panacea for all the ills and troubles encountered.

A map of this portion of the property was then made, and on it was laid down all the topographical notes obtained on the survey, showing roads, streams, cliffs, ridges, valuable timber, etc., and from this the commissioners made the division of the mountain land.

The divisions of the two tracts were then each numbered from one to eleven inclusive, and from our matured knowledge, the *best* share of the bottom was thrown with the *poorest* share of the mountain land and so on, until each was taken up. The shares were then duly allotted in the presence of the attorneys as provided for in the order.

A complete map of the entire tract on a smaller scale showing all the divisions, etc., a corrected description of the whole and of each division, together with the *fee bill* completed the work and constituted our report, which, happily, proved satisfactory, not only to the court, but to each of the eleven heirs.

NOTES.

A Gurley Transit was used in running the lines.

All courses were run by the needle for the reason that the parties in interest did not wish to pay the necessary additional expense. All measurements were made with a one hundred foot steel tape detached from the reel.

Plummets were used as aids in measuring up and down the mountain.

Distances were recorded in feet instead of chains and links.

Contents were given in acres and decimal parts.

A few drops of the oil of pennyroyal on the clothing prevents, in a great measure, chiggers, mosquitoes and ticks from getting in their work.

RECORD OF SURVEYS.

D. W. SEITZ, OTTAWA, O.

As the laws of Ohio require, the county surveyor shall make and keep, in a book to be provided for that purpose, an accurate record of all surveys made by himself, or his deputies, for the purpose of locating any land or road lines, or fixing any corner or monument by which the same may be determined, whether official or otherwise, and also any other surveys made in the county by competent surveyors, duly certified by such surveyors to be correct, and deemed worthy of preservation by the county commissioners to whom the same shall be submitted for approval before being recorded, which surveys shall include corners, distances, azimuths, angles, calculations, plats, and a description of the monuments set up with such references thereto as will aid in finding the same, together with the names of the parties for whom made, the date of making the same, which book shall be kept as a public record by the county surveyor at his office, and shall be at all proper times open to inspection and examination by all persons interested therein, and shall receive the same fees as is allowed county recorders for like work. All county surveyors of this state are, I presume, provided with a book for the purpose intended by law-makers. This is the easy part of the work, but the keeping of an accurate record of all surveys made by himself or his deputies, whether official or otherwise, and of surveys made by competent surveyors and deemed worthy of preservation by the county commissioners, with the fact staring him in the face that he *shall* receive the same fees as is now allowed county recorders for the same work is quite another thing, especially so is the *receiving* of the fees when parties for whom the work is done state that they do not want a record of the survey made and will not pay for it, and when courts decide that the county commissioners need not pay for such records. Yet the county surveyor *shall* make records and *shall* receive fees. If would be far more consoling to the surveyor if some statute would be made stating

who shall pay. I believe county surveyors are just as willing to work for the public as other county officials, but to compel them to *make* a record and to *receive* fees when there is no one to *pay* fees is overloading this particular county official. To compel him to do the work is a load, but to compel him to *receive* fees is preposterous.

In our county we have been making records of all surveys that have been ordered by the parties interested or by the county commissioness, but when records are not ordered we do not make them.

We are using the Holtz form in our records. This form is printed on two pages,—a diagram of the section on a convenient scale on the left hand page and three columns on the right hand page for references. The first column is headed " Original corners as found," the second " Original corners as perpetuated," and the third " Sub-division corners." These refer to the plat or diagram by means of letters used to designate the corners. There is also a space below the diagram ruled convenient for notes, and a blank certificate is printed at the bottom of the right hand page.

We also use " Holtz' Magic Index " in our records, which, together with the above described form, was entered according to Act of Congress in the year 1874, by Lewis E. Holtz, in the office of the Librarian of Congress at Washington, D. C. This index is made on a single page and shows at a glance the page or pages on which all re-surveys are recorded. This is the plan on which the records in this county have been kept for the last twenty years and was introduced in our county by Lewis E. Holtz, C. E. and ex-county surveyor, who has done his "three score years and ten " and is still with us. His axe marks are found on many trees in every part of our county.

I have here a few pages of records kept on this plan for the inspection of members of this society and others who wish to do so, hoping that if there is nothing new in them that they will be the means of bringing out some valuable discussion on this subject.

PLATTING TOWN LOTS.

BY GEORGE M'GORMLEY, TIFFIN, OHIO.

The object of this paper is to lead towards establishing a system of greater uniformity in platting town lots. No branch of surveying has suffered more from careless and inefficient work-

manship, and no branch requires more accurate work. Considering the amount of money expended for buildings, the trouble and annoyance to re-locate lines which are not well defined, the assessments for street improvements of all kinds that are based upon the front foot, are sufficient reasons for accurate work.

Section 2597, R. S., provides: That when any person wishes to lay out a hamlet or village, or sub-division or addition to any municipal corporation, he shall cause it to be surveyed, and a plat or map of it made by a competent surveyor, in which plat or map shall be particularly described and set forth, the streets, alleys, etc.

A competent surveyor. Who is to decide the ability of the surveyor? The proprietor, of course, and the price for which the surveyor will do the work is generally the principal factor in helping him decide upon the competent surveyor. But there are exceptions to this rule. Some persons are willing to pay a reasonable price to have their work well done. The amount of compensation which you are to receive for your work and material should include chainmen, stake-driver, two rodmen, stakes and monuments. If furnished by the surveyor, you can make your own choice and secure competent helpers. The price agreed upon should always be high enough to secure good and competent work. After the price is agreed upon (which, I find is always advisable to settle before commencing work) make a careful survey of the boundary lines by setting stakes at the intersection of all streets, alleys, and other important lines. The surveyor should measure all interior and exterior angles of the addition, and all intersecting lines, which lines should be carefully chained. The boundary line can then be platted upon a scale of fifty (50) or one hundred (100) feet to the inch, or some other scale, convenient to size of plat, using the table of natural tangents to turn all angles, and locating all the adjoining streets and alleys so that the streets and alleys in the addition which you are platting may be made to conform as near as possible to the adjoining streets and alleys. Lay out the plan of your addition upon paper. It should then be presented to the city council or platting commission, not for acceptance, but for an opinion or verbal agreement, that if platted according to the plan, the same will be accepted. This will often save a great deal of labor and expense in the field work. The writer distinctly remembers of additions, which have been re-staked several times, to the detriment of his pocket book and patience, to gratify the whimsical notion of some councilman.

The field work of staking out lots appears to be a very easy thing to do, but in practice, to stake out a large addition so that

all the lines and angles will check, is found to be a difficult problem, and one for which no rule can be made which will apply to all cases. If the addition is large and the streets and alleys are parallel, run check lines on three sides of your addition, staking intersecting points of streets and alleys. Your base line should be run on the remaining side. From your base line stake out your lots into squares, and check the corner stake of each block on your check lines by turning angles and back and fore-sights. If the lines will not check, re-chain them until they will check. Your chainmen will soon see the importance of accurate work and will work very carefully to make the work close. The writer has often closed block after block upon tack heads. The maximum error of all blocks should not exceed five hundredths ($\frac{5}{100}$) of a foot. Temporary stakes should always be set at street intersections or on the side lines, and indicated on the field plan when the blocks are finished, for the setting of monuments. The measure should be a narrow steel band chain adjusted to 60 degrees Farenheit.

PLAT.

The essentials of a good plat are correctness, completeness, and finish. The importance of each being in the order named. It is my practice to make the original plat upon good mounted drafting paper. If the plat is extensive there can be considerable work put upon it. Tracings can then be made from it and blue prints from the tracings. The plat should be drawn upon a scale large enough, without crowding, to fully represent all angles and dimensions. Clearness and distinctness should be the first and most important part. The plat should not be burdened with a mass of pictures or fancy lettering. The title should be clear and distinct, and the letters proportioned to the size and importance of the plat. Plain block letters are suitable for titles. All lines should be black. Block lines should be full with the right hand and lower lines a little heavy. Lot lines should be full and distinct. Where a street is composed of two dedications, they can be separated by a broken line, and the dimensions of each part given on the plat. Street names, figures and dimensions should be neatly printed in black. I think no ink but a good quality of India or French ink should be used for lines and dimensions.

If the plat is a joint addition, tints can be easily applied to show the boundary of each proprietor's portion. As to border, I prefer simply plain black lines. Chains, vines, etc., are too expensive for the surveyor, and are not appreciated by the proprietor.

The plat should show the boundary lines, and distances on said lines, of the area to be platted. The dimensions of all inlots and outlots, the width of all streets and alleys, the exact location of all fixed monuments, the number of all the lots and reserves, and all the angles should be given on the plat.

DESCRIPTION

Section 2597, R. S., also provides for the accurate description to include the courses, boundaries and extent. But, like the competent surveyor, who is to pass upon the accurate description? Perhaps some street committee or commissioners who do not know the difference between a description and a prescription.

When the description of the plat is a legal sub-division or a small portion of a legal sub-division, give the legal sub-division of the section, township, and range on which the plat is located; and also define it by metes and bounds. The surveyor should be careful in selecting the initial point of the survey, and the guide to find it, in my practice, is to take some prominent and permanent point, such as the intersection of two well defined and monumented lines. They should always be as close to the field of operation as is possible to get them, so that the initial point can be located by turning one angle and measuring one line. Never take any movable point to tie on to your initial point. I never detail in the description, the size of lots, blocks, streets, etc. The description is to locate the land embraced in the plat, and the number of acres embraced therein.

SURVEYOR'S EXPLANATION.

The description should be followed by an explanation from the surveyor, stating the manner in which the lots and blocks are numbered, the unit of measure used, the marks used to indicate the position of the monuments, etc., which should be followed by the certificate of the surveyor as to the correctness of the plat, description, etc.

NUMBERING.

Section 2598, R. S., provides for the numbering of in-lots and out-lots, and they are to be numbered in progressive numbers. As to the best mode of numbering lots in all cities I will not say.

Section 2615 to 2620, R. S., provide for the numbering of lots consecutively. And in cities that do not embrace too many

lots, this is a very good mode, as it avoids a great many errors that appear from time to time upon the transfer record.

MONUMENTS.

Section 2599 provides for the setting of monument at the corner of public ground, or a public lot, or if there be none, then at the corner of one of the in-lots; and at the corner of each out-lot, a sufficient stone. Monuments should be composed of indestructible material. They should be from twenty-four (24) to thirty-six (36) inches in length, eight (8) to ten (10) inches square at the base, and dressed to about six (6) inches square at the top. My practice is to drive a heavy oak stake at the point of intersection six or eight inches below the base of the monument, and lay broken brick or tile around the stake. The monument is then set in place so that the upper surface of the monument will conform to the surface of the street, and a small hole, about one inch in depth, drilled into the monument at the point of intersection. If the grade of the street has been established set the monument at the grade of the street. Monuments should be set at the intersection of all street and alley lines, or side lines, and at the intersection of all important lines and angles. In our city we use either sand or limestone for monuments.

LETTERING.

Time cannot be taken to use elaborate letters, and using an irregular or carelessly made letter spoils the work. So the best way is for a draftsman to get in the habit of using a symmetrical free hand letter, which gives a good appearance to the whole drawing.

UNIT OF MEASURE.

The unit of measure should be uniform throughout the work. I prefer feet, and decimals of feet, while some surveyors use a variety in giving the dimensions of a single line. I have seen chains, rods, feet and inches marked upon the same line. This is wrong in my opinion. Use only one unit of measure through the entire plat.

SCALE.

There should be a true diagram of the scale given, and I prefer not to make this too elaborate. A diagram one inch in length is quite sufficient with the ascending scale, commencing at the right hand with 0, and ascending by figures to the left hand.

It is also good practice to give the scales in neatly printed words, under the diagram.

CARDINAL POINTS.

There should be a lettered diagram of the cardinal points. This can be done either by a star, cross or pointed arrow. Give the time, meridian, and line of magnetic variation, in figures.

Section 2600 R. S. provides for the certificate of the surveyor and the acknowledgment of the plat. The following are the forms used by the writer.

SURVEYOR'S CERTIFICATE.

I, ..., Surveyor, de hereby certify that the foregoing description, notes and plat are correct, as surveyed and platted by me, at the instance of the proprietors, this .... day of .... , A. D. 189..... .

...., Surveyor.

Know all men by these presents: That I, ..., owner of the lands embraced in the above plat, do hereby ratify the above survey as therein given, and do hereby approve the plan of said plat; and I do hereby dedicate the streets and alleys not heretofore dedicated to the public use.

Witness my hand this............ day of.................... A. D., 189 ... .
Executed in presence of,.. Proprietor.

....

....

The State of Ohio, } ss.
.................County. }

Before me, the undersigned, a Notary Public, in and for said county, personally came the above named ...., and acknowledged the signing of the foregoing instrument, to be his free and voluntary act and deed, for the uses and purposes therein mentioned.

In testimony whereof I have hereunto subscribed my name and affixed my Notarial Seal this ....day of .... 189 .. .

....Notary Public,

Seal ....County, Ohio.

Office of the City Clerk, }
of the City of.................... O. }

I, ..., Clerk of the City of.................,
do hereby certify that the above plat of...
addition to said city, was duly accepted and approved by an ordinance legally passed; and I do further certify that said ordinance has been duly published.

In testimony whereof I have hereunto set my hand and affixed the Seal of said City, this........day of........ A. D., 189..

Seal

....
City Clerk.

Transferred this....................day of.............. A. D., 189....

....
County Auditor.

....
County, Ohio.

Filed for record this....................day of....................A. D. 189 .
Recorded this ....day of.............. A. D. 189......, in Records of Plats, Volume............., ... County, Ohio.

....
County Recorder.

....
County, O.

Now, in conclusion, if I have succeeded in interesting you, I shall not regret my labor in preparing this paper.

CONVEYANCING.

W. E. PETERS, ATHENS, OHIO.

Of the many important duties which a surveyor is called upon to perform, while engaged in the practice of his profession, none are so important or require such good judgment and fine discrimination as those required in the preparation of the description for the conveyance of real property.

It is made doubly so from the fact that the words, phrases, and grammatical terms, chosen by him in the preparation of the

original description of the exterior boundary lines of the tract, which he has just severed from the whole, will be handed down from ages to come, will be iterated and reiterated, and written and re-written with every transfer, not only of the identical piece of land itself, (and which forms a link in its history that will last as long as time) but will be forever a part of some one of the several pieces into which it may be subdivided, to suit the ever changing wants and desires of a traffic loving nation of people, of whom we are to the manor born.

When we speak of conveyancing we invariably have reference to the contract, termed a deed, as now made, by which the title or ownership of land is transmitted by its owner to his successor by some voluntary act of his own. This method is technically termed "alienation by purchase" to distinguish it from that other called "alienation by descent," or "inheritance," which is defined to be any method by which the title is cast upon one by operation of the law alone.

History tells us that the original owner acquired his title to property by "occupancy." This is defined to be "the taking possession of those things which before belonged to nobody; yet we have evidence in the holy writ (Gen. I, 28) that the Creator was the original grantor, and that he gave to man "dominion over all the earth, and over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth."

For a long time all property was held in common. What was the property of one was the property of all. But human avarice and love of gain was developed at an early date. The weaker was forced to give to the stronger; the few to the many. It was soon learned that "in unity there was strength." Municipal society was, therefore, early made a necessity, and at once interposed and decreed that property should be held in severalty. An estate in severalty is one held individually and exclusively by the owner thereof. It is defined by Blackstone to be one "held by a person in his own right only, without any other person being joined or connected with him, in point of interest, during his estate therein." When this period was reached it was no longer practical to dwell together and we find in sacred history that Abraham thus said to Lot: "Let there be no strife, I pray thee, between thee and me. Is not the whole land before thee? Separate thyself, I pray thee, from me. If thou wilt take the left hand, then I will go to the right; or if thou depart to the right hand, then I will go to the left."

After the barbarous period of the middle ages, when the

swords were being forged into plow shares and shepherd's crooks, when society began to be better organized, the rights of the individual to the land which he occupied was, in turn, better recognized. It was at that period that the rights of the son to succeed to the father's estate, upon his decease, was first conceived and conceded. Hence the inauguration of the alienation of property by descent, which was not at first so much upon the principle of paternal love and filial affection as it was upon the theory of original occupation, in that it was theoretically reasoned that the son was the first person upon the premises after the death of the father.

Manual delivery of real property being impossible, symbolical delivery was necessarily resorted to; and hence we read in history of the owner thereof delivering to the purchaser a clod or turf, or a twig, or the latch of the door, with the words: "I deliver these to you in the name of seizin of all the land I herewith convey to you."

Among the early uses to which the art of writing was applied was to witness the transfer of real property. Of the many methods of so doing, one was that by "deed of indenture," which originated in the desire of both vendor and vendee to have each a copy of the contract of sale, and hence the article of agreement was written in duplicate, upon one piece of paper or parchment, with some word or other character written between them, through which the paper was cut in a zigzag, or indented line, in such a manner as to leave half of the word or character upon one part and half upon the other.

A deed made and signed by the vendor only is not indented, but is polled or shaved quite even, whence the name "deed poll" or single deed. This is such a deed as we use most at this day, and in the preparation of which we, as surveyors, furnish so important a part.

In treatises on conveyancing, deeds are usually separated into several heads or parts, each of which is dwelt upon with much minutia.

With the preparation of the formal parts of a deed, in this day and age of the printing press, the surveyor should studiously avoid having anything to do. However simple and easily prepared and applied they may seem to be, they are nevertheless the results of much labor and study by the best and ablest lawyers of the different preceding ages. They have stood the tests of time. They have time without number been put upon the "rack" in the presence of court after court, and tested and found

not wanting, and now it is not within the province of the surveyors to venture a change of those parts

Whenever other than the common and ordinary forms are required it would be a wise precaution to furnish some lawyer with the proper description, carefully prepared, and let him apply his professional knowledge to meet the exigencies of the case. Of course do not fail to arrange with him for a proper division of the fees.

The technical terms in the alienation of property are so subtle that none but a lawyer who has read the law of real property, should venture to step aside from the beaten path. Very often he is not able to see, or at least does not see, the lurking foe in the brushy wayside, and may draw a very faulty contract; but if he is not either forearmed or forewarned, or both, I am sure I do not know to whom we could flee for refuge and solace in our hour of woe.

In England the law of conveyancing is so technical and abstruse, and the forms are so lengthy, long drawn out and complicated, that it is made a distinct and important branch of the legal profession. A long apprenticeship is required to make an expert and reliable conveyancer. Early in the history of conveyancing conveyancers were paid by the amount of writing that was to be done, by the job, so to speak. Hence the lengthy and tautological methods resorted to.

The inclination of the American people has always been towards brevity in all their forms of business, and their deeds of conveyancing form no exceptions. They now present a marked contrast to those in use in England, or even to those in use in this country only a few years ago when it was endeavored to follow in the footsteps of the mother country, from whom we have copied so much of our law and forms. However, "brevity is the soul of wit," and nowhere is it more in place than in the description of property. Its application should be studiously observed by the surveyor in the preparation of such descriptions. Brevity, however, should not be had at the expense of being explicit. Select, then, your words and phrases with care. By all means avoid tautology. When you have once expressed the idea intended, be sure it is accurate, and then add nothing more but the period. Paper is cheap, pens and ink are likewise so, and all necessary words can be had for a little labor. Sacrifice nothing, then, for brevity, simply for brevity's sake.

Formerly the conveyance of real property was made by *parole*, or word of mouth, only, but as this gave rise to many opportunities for fraud, the celebrated statute of Fraud and Perjuries,

was, at an early date, made a necessity. This very excellent law was enacted by the English Parliament in the year 1677, during the 29th year of the reign of Charles the Second.

This law, in brief, in so far as it related to real estate, required the transfer of all interest in any freehold hereditament to be in writing and signed at the end thereof by the grantor, or his agent lawfully authorized in writing so to do.

Now, in the preparation of a deed, there are several rules which the surveyor can follow to much advantage. Some of these are deduced from the early decisions of courts, and have ever since been the templet to which the later decisions have been built. They have been time tried and court tested. They have become such well established rules of law that the jurist and judge alike studiously endeavor to fit the cloth of the particular case in hand, to the model of some well established precedent.

In the enumeration of rules I shall begin with one which is of my own invention, and one within which I have always endeavored to bring descriptions of all property, save that of which a plat had been legally recorded, and in the conveyance of the respective lots and parcels of which the use of the proper lot numbers would be more appropriate. My rule is that it should be such a description of the property, about to be conveyed, as will enable one to make a plat of the premises by the use of the description alone. The application of this rule would not eliminate all of the one thousand and one objectionable elements of error that creep in, but will materially reduce their number, and be a source of much satisfaction, I am sure, to the surveyor who may be called upon to retrace the property lines, or to prepare a plat of the premises.

The courts have declared the rule that "where boundaries are given with reference to fixed and known objects, they control courses and distances," to be universal. The cases in which this rule has been applied are legion, and the law writers cite but few authorities deeming it folly to burden their works with an enumeration of the cases in which that undisputed rule has been upheld.

One of our able writers gives as the evident reason for the universal application of this fundamental rule, that "an error is more easily committed in matters, requiring care and skill, which are rare, than in matters of eyesight, which is common. A call for a planted stone, a marked tree, the established line of the section known to the whole township, ought for this reason, to be assumed to have been what was intended to mark the boundary line, rather than a line determined by the magnetic needle, the

ıccuracy of which is a question of skillful observation and local ıttraction. Again, it has been decided that if there is no descrip-.ion less liable to mistakes, or no monuments are mentioned, or, if nentioned, their existence and location not proved, courses and listances will control.

In other words that which is most certain will give way to hat which is less certain.

In the construction and interpretation of a deed the courts ›lace themselves, as nearly as possible, in the situation of the par-ies whose intentions they are endeavoring to ascertain.

The primary rule of considering the contract as a whole, or ın entirety, is applied, and their conclusions deduced therefrom.

We must also remember that all quantity of land called for n a deed, as being so many acres, must yield to the lines formed ›y the direct connection of the marks and call in such deed; and hat the quantity of land mentioned therein is regarded as a part ›f the description only, unless there is an express agreement as o quantity, in which case the difference should be adjusted by he original contractors.

A reference to another deed or plat has the effect of incor-›orating such deed or plat into that deed, and makes them part ınd parcel thereof as completely as though they were literally :opied therein. Thus a deed, the description of which apparent-y correctly bounds the land by courses and distances, and is fol-owed by the words "being the same premises conveyed by "A" :o "B" the grantor herein, dated .... day of .... " or "by deed recorded in volume .... page.............. of record of leeds" would convey the whole tract of land described in that leed, even though the latter deed had omitted a strip.

It may, therefore, sometimes be a wise precaution, when you ıre unable to prepare just such a description as you may wish, :o apply a sort of "blanket clause" at the end of your descrip-:ion, and say "The premises hereby conveyed are the same as hose conveyed to the grantor by 'A' by deed dated" etc., etc., ›r "being the same premises now owned and occupied by the aid grantor herein." This course should be adopted only in ex-reme cases when better descriptions can not be obtained but at nore expense than your employer can be induced to incur.

SURVEY OF THE BOUNDARY LINES BETWEEN OHIO AND INDIANA AND OHIO AND MICHIGAN.

BY MR. GRAHAM.

Mr. Chairman and Gentlemen of this Society:

Under authority of the general assembly last summer I was authorized by the governor to investigate the boundary question between Ohio and Indiana, and Ohio and Michigan, the line being in dispute. I have for ten years been gathering the material on that question and have it collated, and it was simply necessary to write it out and add to it the original charts and maps. In addition to that Dr. Mendenhall, of the U. S. Coast Survey, sent two of his assistants who made astronomical observations and found it to be an incorrect meridian line. I hardly know what you want to know about that line, except to describe it as it is, and then answer such questions as may occur to you. I cannot go into it technically, for lack of time, and have not studied that part of this question enough; and further I have just come back, as some of you know, from the sanitarium trying to recover from the grippe. I can best illustrate what I have to say by diagrams on the blackboard, then take up the salient points of the law which established the boundaries. The observations made by Mr. Mendenhall are here, and if any of you wish to take these and figure out how far the line is incorrect from a true meridian line, it will be easy for you to do that. These plats I make will not be very accurate but I can give you the correct idea, I think. The law of the northwest territory, passed by Congress in 1784, divided the territory of the northwest into three states, afterwards into five states,—that is, it was to be divided into three states. Beginning at the Mississippi river, the western boundary of one state, to the Wabash river and running north from Vincennes; and beginning at the mouth of the Miami river and running north to the territorial line. There was to be an eastern state, a middle state and a western state. No names were given to these states. The law provided also that if in the future it was seen to be best to subdivide these three states they might create two states additional in the territory north of a line drawn east and west through the southern extremity of Lake Michigan. The law does not say that the territory north of this line shall be a state, but *in the territory* north of that line there may be a state. The Ordinance provided that the first state should be bounded on the west by the Mississippi river, the second one following the Wabash river from its mouth to Post Vincennes. It does not

any cardinal point in Vincennes, hence it is a difficult point to
w where that line started. The presumption is that it was on
bank of the river, or at least not farther west than the middle
the river, and north to Lake Michigan. Then the next
e should be bounded by that line, the Ohio river, and a
starting from the mouth of the Miami river and running
north to the territorial line. These words occur in every
of Congress passed regarding that line, that it shall start
n the mouth of the Miami river and run due north to the
itorial line. Afterwards the laws begin to say that it shall
a *meridian line* that starts at the mouth of the Miami
er. As I understand it a meridian line is nothing but a
ight line. The constitution of Ohio, which was acknowl-
ged by Congress, states that this line shall be a meridian
e beginning at the mouth of the Miami river and running
th to the territorial line. Ohio was admitted in 1803, and
e act of Congress that provided for admission was passed
April. 1802. Indiana territory was created in 1801 or 1802.
e state was admitted in 1811. Congress, when it admitted
iana, fixed the eastern boundary as a meridian line—that
the exact words in the act of Congress the meridian line
ich forms the western boundary of Ohio. The constitution
Indiana, passed by her own convention in 1811, states that
e eastern boundary of the state shall be the meridian line
ich forms the western boundary of Ohio. That line was
er surveyed and was never marked, and this point comes
o dispute immediately;—is the present boundary on that
ridian line? Indiana says now that the line, as it exists
day, has been there a hundred years, and that you cannot
nge it. Lieutenant Merril, late of the United States En-
eers office at Cincinnati, in letters to me prior to his death,
d he understood that if the boundary was once fixed (right
wrong) no act of Congress or of a state legislature could
nge it. The officers of Washington do not agree with
t, and cite the fact that the United States government has
en changed its boundary and state boundaries have been
nged. Just after Wayne's campaign of 1794 a treaty was
de with the Indians which ran a line up to Cuyahoga river
old Fort Laurens, then south-westerly to Fort Loramie,
nce north-west to Fort Recovery, and thence almost south
the Ohio river. North of this line was all Indian Terri-
y, while east and south of this line the country was open
settlement. Congress passed a law shortly after that, for
purpose of civil government, that the portion of the ter-

ritory east of a line traced on this treaty line to Fort Recovery, and thence straight north, should be the division line between the eastern portion of the north-west territory and the western portion, a civil division. That line was never surveyed. It was accepted as a civil division line for governmental purposes, and Cincinnati was made the seat of government, of the eastern division.

When Ohio was admitted to the Union, or when Congress passed the act that admitted Ohio to the Union, the boundary on the east was fixed on the Pennsylvania line, and down to the Ohio river; then from the Ohio river, due *north from the mouth of the Miami river*, to the British possessions or to the line Congress had established on the north, and then following the territorial line of Lake Erie. That should be the northern boundary. The state was not named then, but in framing the constitution it was called Ohio. The old laws do not call it Ohio. That line remained practically undisputed until 1837. In 1811 Indiana was admitted as a state, and reaffirmed that her eastern boundary should be a meridian line starting at the mouth of the Miami river. In 1837 some doubts existed as to where that line began. Those who live in the southern part of the state, or who have been at the mouth of the Miami river, know that it is more than a mile from where it was a hundred years ago; it originally described a turn, making a great bend that was afterwards cut off. Like all rivers, it is constantly washing away, hence the mouth of the river is now considerably down the Ohio river from where it was a hundred years age. If the boundary line is to start from the mouth of the Miami river, it will be a fluctuating boundary line just as long as that river goes up and down the Ohio river. In 1837 a resolution was introduced into the Ohio Asssmbly and into the Indiana Assembly asking for the appointment of a commission, one from each state, and authorizing the appointment of surveyors to ascertain where that line began. Mr. Matson, representing Ohio, and the Indiana Commissioner met at Lawrenceberg, just below the outlet of the Miami river, and there appointed surveyors, who started with what knowledge they could obtain and made a survey from the middle of the river out to the bank, and there established a post, and then ran north from that to where the road crosses the boundary from Elizabethtown to Lawrenceberg. There they made another point and there put up a stone post eight feet high with about an 8-foot base, sunk about four feet in the ground and running up to

a point. They put suitable marks on it stating it was on the meridian line beginning at the mouth of the Miami river and on the boundary between the states. They marked it properly, placing the date, 1837, on it. They also put one on the right bank of the mouth of the Miami river, and then described how many chains and links it was from the centre of the river to the monument, and that it was directly south from the other. They made these two points as beginning points on the line between Ohio and Indiana. When the bridge was built crossing the Ohio river afterwards, the workmen discovered this stone buried under about fifteen feet of river debris, and perhaps one hundred feet down from where it was supposed to be. It had been undermined and gradually pushed out by the river. They found it under fifteen or twenty feet of deposits and left it there. We don't know where it is now. The stone post that stands on the Lawrenceberg road, on the right bank of the canal, is there yet, and when Mr. Putnam went to examine it, he found it covered an inch or an inch and one-half thick with circus posters. They took some off and found the date 1837, and supposed it was the post I referred to. They made it as one of the base stations, then another at Union City, and another at Butler. They state that if a line was run due north from this post it would run considerably west and take in quite a little strip of Indiana, nearly 100 square miles, running any where from a rod wide to nearly two miles wide. If you care to have the report read I will read that to get the exact figures. Also if you care to take the report and the observations then made, you can do so. That is all that has ever been done on that line. It is a zig-zag line. People living along the line don't know where it is half the time. An examination of the land surveys, and also of the farm lands, shows that many of these men are constantly in court with the officials of Ohio and Indiana, claiming they are taxed unlawfully, and many of them are paying taxes in both states on the same piece of property. It is the same way on the Michigan line. I have a letter from a farmer who states that he has for twenty years disputed with the authorities of Michigan, and that they have compelled him to pay taxes in both states. In regard to the surveys of the Ohio and Indiana line:—In 1795 a land law was passed which provided for the survey of the United States lands into townships six miles square. This survey began from the point on the Ohio river where the Pennsylvania line crosses it. The law pro-

vided that every seven ranges should be returned to the treasury, and certain portions sold for the benefit of the United States, and certain portions for the benefit of the states. The ranges were to be numbered from the east to the west, and the townships numbered north from the Ohio river. They only surveyed seven of these ranges, and of these only the exterior boundaries. They did not survey them into sections. The Indian war broke out and they were obliged to give it up. The people who settled at Marietta secured a tract of land on the Ohio river and surveyed theirs upon the same plan, making the Ohio river the base, and making the townships six miles square. In 1885 I wrote, at the request of General Robinson, then secretary of state, a full account of the land system of the State of Ohio and the survey system. I found on investigating this portion, that the Yankees, in their transactions, had carried out their true Yankee spirit to the letter. Congress allowed them to survey this land and gave them 100,000 acres, and also provided that they could buy so many acres of land—about 1,500,000 acres. They surveyed at that time with a compass, and I shall describe a little further about some compass work north of the Ohio river. These old fellows knew that the needle varied east and west. There is not a perfectly straight line as far as I have been able to find in any of these land surveys that were run by the needle. It will vary one way or the other. You can see if it varied east, the old fellows lost land; but if it varied to the west, they gained it. In 1818, to try to settle some of the land disputes in this part of Ohio, the United States government ran a correctional line about the 18th meridian straight through to Lake Erie. When they came to measure from that line to the Ohio Company's purchase, they found that these Yankees were very careful that the needle went to the left, and there is not the slightest doubt but that they got more land than they were legally entitled to. West of the Scioto river comes the Virginia Military District. West of that the two Miamis and Symmes' purchase. The same error was found afterwards in investigation of Symmes' titles.

In 1798 Mr. Edward Tiffin was the Surveyor General, and located at Chillicothe. He sent a surveyor to survey the land between the west boundary of Ohio, Symme's purchase, and the Miami river. For some reason—I don't know why, and I have never been able to find out,—instead of making the Ohio river their base line and surveying north,

they made the old Indian boundary line the base line and surveyed east to the Symmes' purchase and the Great Miami, and numbered their ranges from north to south instead of from east to west, as they had done heretofore. When they had come to the Ohio boundary line they merely surveyed it, and marked it in the surveys as the *first meridian* line. They knew it would be the boundary line between the eastern division of the territory, and the territory west. They surveyed the United States sections east and west of that. They were entitled to survey under Wayne's treaty with the Indians, up to where the Indian boundary line crossed. They could not survey any further north than that, and that has never been surveyed as a boundary. It has simply been surveyed by the United States surveyors as a base line. The United States surveyors, when they came to run their line, used that as a base line running both ways, but they did not use it as a *dividing* line between the states. In 1817 there was some dispute as to this boundary, and Congress authorized the Land Commissioner to have a survey made north from the point where the Indian line crossed the meridian line, and Mr. Tiffin employed William Harris, who ran that line beginning at a point 89 miles north of the mouth of the Miami river. He surveyed north until he came to the line running from the southern extremity of Lake Michigan to Lake Erie. He states in his letter - and I have a copy of his survey—that he surveyed that under a great many difficulties. Sometimes they had trouble with the Indians; sometimes they were obliged to send their horses with implements and supplies around the swamps. His letter states that his survey is not, in his opinion, correct; and that he will have to run the line again; but I cannot find that he did so. His survey has been accepted as the boundary, and in that condition the line remains to-day.

The only thing that can be done is to do as we did with Pennsylvania—appoint a joint commission to determine where that line is, or where it should be, and mark it properly. That is, in a nut-shell, a rough outline of that line between Ohio and Indiana, and before we go into the Michigan question, I will stop and ask if there is anything I have omitted that you would like to know.

The President—Gentlemen, any member of the Society who may wish to ask a question of Mr. Graham may do so. It might be of interest to some of us to learn what field

work has been done and referred to in the report which he spoke of.

Mr. Arnett--I would like to ask if the line was ever run and marked.

Mr. Graham—No, it was never properly run and marked.

Mr. Arnett—It was to run *due* north.

Mr. Graham—Yes, sir. The law originally says it shall run *due north* from the mouth of the Miami river. That was never surveyed from the Miami river north.

Mr. Arnett—And there never was any line run or marked?

Mr. Graham—No, sir, there was a line run from where the treaty line crosses the meridian line north to the Michigan line, as I said a while ago, by Mr. Harris in 1817, but his letters state he had made some mistakes and would have to run it over. The boundary line between the states to-day is not a straight line.

Mr. Arnett—If it is a meridian line it ought to be straight.

Mr. Graham—Yes. If you follow the ordinance that provided for the provision of the territory into three states you must make that line a meridian line. The constitution of Ohio says that it shall be a meridian line, and the constitution of Indiana says it shall be a meridian line.

Mr. Arnett—Well, run a meridian line then.

Mr. Graham—That is the point to be decided.

Mr. Davisson—Did I understand you to say that the line from the mouth of the Miami river north to that first dot there had never been surveyed, that is to Fort Recovery?

Mr. Graham—That is the old Indian boundary line, and was used a short time only as a civil division line.

Mr. Davisson—I know, but it was surveyed by the government surveyors.

Mr. Graham—No, it was not a goverment survey.

Mr. Davisson—I mean the present line?

Mr. Graham—Yes, sir, this was made by the United States surveyors who began in 1798 and finished about 1801. but they didn't survey that line at all. They surveyed the townships east and west of it and made that line the dividing line between the townships.

Mr. Davisson—They surely must have surveyed that line, because they located corners.

Mr. Graham—That is true. They surveyed it just as

they surveyed every one of these township lines. They did not survey it as a *boundary* line, they surveyed it as a *township* line. They say in their report that this is *to be* the boundary line between the states. They knew that, but they did not survey it as a *boundary* line. So that as a boundary line from this point to that point it has never been run.

Mr. Davisson—They seem to describe it in their own plats as a boundary line.

Mr. Graham—They refer to it as a boundary line, but they did not survey it *as such*. If they had they would have established their meridian properly here. Their report shows that they surveyed this line just the same as they surveyed other township lines. They knew that it would be the boundary line between the states, but they did not survey it as such. They surveyed the townships up to it, of course, and surveyed the exterior part of the townships.

A member—From the mouth of the Miami river is that a magnetic line, a true north line?

Mr. Graham—It is not a true north line.

A Member—Did they attempt to make it a true north line?

Mr. Graham—They attempted it, but they surveyed with a compass, and, as I said a while ago, I have never yet seen an absolutely true meridian line run with a compass. Surveyors tell me, in the different parts of the state, that it is a very common thing in surveying land to find little jogs in the lines.

A Member—Did you ever see a straight line, run by the compass, that was five miles long?

Mr. Graham—I have never yet, in the examination of the land system of Ohio, found an absolute meridian line run by the needle. If there are any I would be very glad to know where they are.

Mr. Davisson—Do you think it probable that that line will ever be changed?

Mr. Graham—I cannot tell. I have talked to men who claim to be good constitutional lawyers, and have asked them that question. A lawyer from Lancaster asked me about this question, and I said to him that the law of Ohio and the law of Indiana and the laws of the United States required a meridian line. I said it is not a meridian line, there are a hundred square miles of Ohio over in Indiana. Now, I said to him, Indiana

comes in and says you cannot change the line now, it has been there one hundred years. Well, said he, it can be changed, and we have a right to change it, and a right to that territory.

There, now, are the two sides of the question before you.

I will now take up the northern boundary and explain that a litttle. The act of Congress that provided for the east and west line through the southern extremity of Lake Michigan provided that, from a point on the southern extremity of Lake Michigan, a line should be run due east and west reaching from the Mississippi river until it intersected Lake Erie, thence to the boundary line between the United States and the British possessions in Lake Erie, and from thence to the Pennsylvania line, that line to be the dividing line between the states; and in the portion north of this line two states could be created. The maps of 1788, and even as late as 1805, show that if you run a line straight from the southern extremity of Lake Michigan east you would run into the Detroit strait, entirely north of Lake Erie. That map was before the committee of Congress when they made that division, and the line was drawn supposing it would run from the southern extremity of Lake Michigan into the Detroit straits, and there strike the division line between the United States and the British possessions. It was accepted as such and nothing said about it. In 1802, when the constitution of Ohio was framed, and while they were deliberating about the north boundary at Chillicothe, an Indian trader came in and mentioned to one or two of the representatives, that the true southern point of Lake Michigan was a good many degrees further south than laid down on these maps, and that if they ran a line from the southern extremity of Lake Michigan east they would strike just about the mouth of the Maumee river. That set our old Buckeye progenitors thinking. They wanted the mouth of that river, and in fixing the north boundary of Ohio they stipulated that in case this line did not intersect Lake Erie on the boundary line north of the outlet of the Maumee River, it shall run northeasterly until it strikes the north cape of the Maumee bay. Tney also stipulated that the line should have the assent of Congress. When the constitution of Ohio came before Congress in January, 1803, it was referred to a committee. That committee in making its report to Congress stated that this question, that had been sprung in the constitution of Ohio, was not submitted to them *separately*, and, consequently, they would not make any report on it; but they advised that the constitution be accepted. Congress accepted the constitution of Ohio with the boundaries defined in the constitution. Consequently the people of Ohio

always contended that the acceptance of the constitution was an assent of Congress. If you will read the debates of Congress you will find some pretty heavy debating, by such men as Thomas Ewing, as to what *is an assent of Congress*. Ewing claimed that the acceptance was an assent and that they could not get out of it. Also the Ohio people contended that the act of Congress fixing that original east and west line was done under a misapprehension of the facts of the case, and that if a line was run due east from the southern extremity of Lake Michigan it would not strike the territorial line in Lake Erie at all, and therefore it was an impossible line. They said it should intersect Lake Erie and the territorial line, and then to the Pennsylvania line. You may take a map and draw a straight line east from the southern extremity of Lake Michigan and you will run through the Sandusky bay and cut off a lot of Ohio. The Ohio members of Congress also contended that it was not intended that a line should be run leaving this part of Ohio belonging to Michigan or Canada. They had these two reasons to support their theory. Michigan contended that the line should follow the old east and west line to Lake Erie and then north to the boundary, and that no act of Congress could change the ordinance of 1787. When Congress, in 1805, created the territory of Michigan, she fixed the line upon the "Fulton" line, and hence overlapped Ohio's claims. When Michigan came to be admitted in 1837 she made a vigorous argument that Congress had established her southern line on the Fulton line, and that it would have to stand. The question was submitted to General Butler, the attorney-general of the United States, who reported to the president that the claim of Michigan was a good one, but he also stated that it was not advisable for Congress to insist upon that. Here is a copy of a map made in 1718 showing the Harris line from Fort Recovery north, and showing the Harris line from the southern extremity of Lake Michigan running north-easterly to the Maumee bay, and also showing the survey of John Fulton, running east and coming into Lake Erie south from the Maumee river. The line run by Fulton left the mouth of the Maumee in Michigan. The Fulton line was run in 1817. Lewis Gass, governor of the territory of Michigan, induced the land office to run the Fulton line. In 1837, when Michigan was admitted as a state, that question came up, when we had no little trouble with Michigan and came so near having a war. If you will look at the correspondence you will see that Governor Lucas never said anything about this being the line of survey. He would always say *a* line from the southern extremity of Lake Michigan to the

southern point of the Maumee cape. There is a stone post there now showing where it terminates. Ohio appointed three commissioners to survey the line from the Indiana line eastward. When they had surveyed about 28 or 30 miles they were arrested by the authorities in Michigan. Part of them escaped and part of them were taken up by the authorities. It was only by the interference of President Jackson that a war was prevented. Ohio called out her troops, appropriated $300,000, and prepared to go to work. Jackson appointed a commission who came out here and counseled peace. In their negotiations they proposed to each Governor that all hostilities should cease, that this line should be surveyed undisturbed, and the question be submitted to Congress for settlement. Governor Gass of Michigan was a beligerent old fellow. Governor Lucas would not communicate with him. He would not have anything to do with the territorial legislature. He claimed the territory had nothing to do with the boundaries, that Congress fixed them and he would not communicate with them except in a civil way. These commissioners got the proceedings stopped and the surveyors went on and finished the Harris line, and at the north west corner of the state they put up a large pile of stones and put in a cedar post eight or ten feet high. On one side they marked the letter "O," on another the letter "M," and on another the letter "I". Then they started east, and at certain intervals planted posts of hard wood. They surveyed the line as a boundary line, and that survey was accepted. When their survey was sent to Washington and the question came up in the Congress of the United States, as you all know, it resulted in Michigan being admitted as a state with the Harris line as a boundary line between Michigan and Ohio. To propitiate Michigan they gave her the upper peninsula which she did not want then, but she would not trade now for this little strip of territory here. Then the United States land office sent their surveyors and surveyed the township lines on that line. If you take up a map of Ohio, a large one, you will see that on this Michigan line the townships do not coincide with the townships in Ohio. You will find a jog in the line. I asked the Land Office in Washington why that was done when they surveyed the townships,—how did it happen these lines did not run right straight through. They explained it by saying the base line in Michigan differed from the base line in Ohio.

The United States surveyors, in surveying the land north and south of the Harris line, marked every township corner with a post. That line has been surveyed as a boundary line three different times, and stands that way to-day. So there cannot be

ıy dispute about the line between Ohio and Michigan, except ıat it ought to be run and marked with stone posts. Many .rmers on that line are paying taxes in both states. An investi- ation shows that the old fellows who settled there, when they und one of these posts in the way, simply took it out and t it over. They did the same thing in Michigan, and now they e in trouble paying taxes for it.

Mr. Bowen—Did these fellows come from Marietta?

Mr. Graham—Some of them did. Many of these cedar posts oak posts have been taken out, on a roadway being built along ıe line, they don't know exactly whether that boundary line is the middle of the road or one side of it, or whether it follows line fence or not. All these places ought to be marked with one posts. I have a report at the State House between Ohio nd Pennsylvania. Pennsylvania has had every foot of her oundary surveyed, and at every mile a stone post planted. There a severe law against meddling with these posts. There is no ouble about the Pennsylvania and Ohio lines, and there ought be the same thing here. When I was up in the northern part f the Virginia Military District I ran across this fact. Here is a ough outline. This is the Miami river, this is the Scioto river, nd here is the Virginia Military District. A good honest old ierman found a creek coming in this way. He examined the ıw and found out that he could turn the creek out that way. He imply dug a ditch around here and got all that land. He is a ood old dutchman, too. So you see the yankees are not to lame for all of it.

The President—There is one thing I would like to say, gentle- ıan, about that line between Ohio and Michigan. What Mr. Graham has said is true. There is one other side to that question, owever. Up in Lucas county, Ohio, so far as we can ascer- ain, there is some land not paying any taxes. So one hand vashes the other. We are all under very great obligations to Ir. Graham for his very instructive talk this morning, and if you vill kindly allow the secretary to take such portions of his report s relates to the field work to be published in the proceedings, I ave no doubt we shall all find it very valuable, or at least some vill find it valuable, and it will be placed among the records of ur society.

Professor Brown—I would like to ask one or two questions. Ir. Graham spoke of the surveys of the Ohio company's purchase nd the Western Reserve. Why were the townships cut into mall lots?

Mr. Graham—The reason the land was divided into smaller lots on the Western Reserve simply lies in the ingenuity of these people. The law under which the seven range land was surveyed provided that the land should be sold, I think, at $2 or $2.50 per acre. They found a very slow sale for it. It had to be paid for in coin. Remember this Western Reserve was private property. They surveyed that into small parts. If a man wanted ten acres he could get it. The townships were five miles square and divided into smaller lots. If you get the report of 1885, the report that I wrote for General Robinson, I think, you will find it explained there.

Mr. Bowen—The United States military district was fixed by act of congress. Didn't that provide the size of the townships?

Mr. Graham—I think so.

Mr. Arnett—With regard to this line between Ohio and Indiana, if the government of the United States has fixed it as a due north line, and the government of Ohio claims a due north line, and the government of Indiana claims a due north line, and the line has not been run, it would seem as if these two states were tenants in common of that line there, and it would have to be divided as in the case of two heirs.

Mr. Dunn—I move a vote of thanks be extended to Mr. Graham for his instructive talk.

A Member—I second the motion.

Mr. Bowen—I move, not exactly that it be amended, but that in addition, in consideration of Mr. Graham's interesting talk this morning and the information he has given us, I think he is entitled to something more than that. I would therefore move that in addition to a vote of thanks Mr. Graham be elected an honorary member of our society.

Mr. Dunn—I will accept that as an amendment.

The question coming upon the motion it was carried.

Mr. Graham—Gentlemen, I am much obliged to you for the honor. I did not expect anything of the kind, and if I had the time I should like to occupy it by learning a little more about surveying. In regard to this report I will say that it will go to the governor, and I think will be sent to the general assembly, with a request to print it for distribution. I think each of you ought to have a copy. If it is not printed by the legislature, the State Historical Society will take steps to print it in full, and you can get copies of them.

Mr. Burgess—There is just one little matter in connection with

that Western Reserve survey that I want to show these gentlemen. I know it will amuse them all. This is the Pennsylvania line, (illustrating on the black-board) and this is the lake shore. Here is the Western Reserve. It was divided into five mile districts or townships by the surveyor. They commenced running their lines on the Pennsylvania line and placed posts along; then taking these lines they ran north by the magnetic needle, and the result of it was, when they got up there on the lake, they had sometimes four, sometimes six, and sometimes five; but they ran the whole sixty miles straight through the timber by the magnetic needle without any measurements off the base line.

Mr. Graham—It is the same way with the townships on the Ohio river.

Mr. Burgess—That is the only case where I knew land lines to be run sixty or seventy miles by the magnetic needle.

THE ANNUAL CHANGE IN THE DECLINATION OF THE MAGNETIC NEEDLE—IS IT A CONSTANT QUANTITY?

E. W. DIMOCK, DUPONT, O.

That mysterious property in nature known as terrestrial magnetism doubtless has its origin in thermo-electric currents moving through the earth, impelled by the sun's energy, as a positive force. And when the amount of this calorific force is measured, and it is remembered that every part of the earth's surface below the polar circles must successively face the fiery orb each twenty-four hours, it will be easy to consider the earth as a vast battery whose thermal currents circulate through ocean and mountain with their ceaseless flow, and whose direction will slightly vary in accordance with the change in the sun's apparent position. This direction may be supposed to follow the earth's equatorial circumference.

The known tendency of the magnetic needle to take a position at right angles to an electric current was observed soon after Galvani gave his discovery to the world.

Van Oersted, a professor of natural sciences of the University of Copenhagen, by the construction of a heliacal ring, showed that the passage of galvanic currents therein tended powerfully to produce polarity in the circumscribed body. Ferruginous

and other substances more or less susceptible to magnetic action, lying in or near the track of thermal force, have, in process of time, their molecules arranged in magnetic order, so that it was shrewdly suspected that magnetism so-called is only a resultant force, that it cannot appear unless evolved by electric energy.

The early discovery of the magnetic needle, said to have been by the Chinese at a remote period, though this is by no means certain, furnished an aid to navigation that must have been of great utility. Its eccentricities and erratic movements were probably entirely unknown, and it was not until Columbus, sailing continuously in a westward direction, had passed the Azores, that its deviation was perceived. These curious abberrations have been observed for quite a lengthy period, and as long ago as 1580, at Paris, the north end of the needle was observed to have its extreme eastern declination, being 11½ deg. E. It now retrograded, moving westerly for 234 years, until the magnetic declination was 22° 34′ W., its maximum, making an average annual change of 8.7′.

At London, from the year 1662 to 1700, the annual change was 15′, from 1700 to 1778, 9.6′; from 1778 to 1815 3.7′; and from 1815 to 1843, 2.8′.

The maximum eastern declination in this country, appears to have been reached in about 1808, since when the movement has been westward.

On the eastern hemisphere, it appears, from the foregoing data, that in point of quantity the greatest declination is west: that the needle vibrates through an arc of 34° to 35°; that the point of central passage through this arc is at about 5¾° W., from the time of the passage of which the needle will return in about 234 years.

Relative to the annual westward movement of the needle in this country, some interesting data were published as long ago as from 1840 to 1842, by Prof. Loomis, in Silliman's American Journal. These related chiefly to the different rates of motion, at different localities in the U. S., and a table of these observations may be found in Gillespies Sur. P 205, 3rd. Ed.

As a reference, that may perhaps be of some use in any further investigation of this subject, the writer offers the following:

In 1821, James Riley, a deputy surveyor employed in the Surveys of Public Lands in this region Lat. 41° N. Long. 84° 18′ W., noted in his Journal the variation of the needle at 4° 42′ E. Thirteen years later a resurvey was made of a portion of territory which at the time of original survey was left undisturbed, it then being an Indian Reservation. By his record after 13 years

had elapsed 35′ less declination was now observed, which amounted to about 2.7′ per year.

In 1880, the result of a series of observations taken by the writer, to determine the magnetic declination gave 1° 7′ E at 8 o'clock A. M., which amounts to a mean annual change since 1821 of about 3.6′.

Various observations taken during the last ten years appear to indicate an accelarated motion since that time, and an observation of Polaris on the meridian, had Dec. 12, 1891, gives only 12′ declination east of the true meridian, which amounts to about 3.8′ annual westward motion since 1821.

The writer has nothing further to offer relative to this subject, but to suggest, first, that the Ohio Society of S. & C. E., by a duly authorized committee, institute a series of observations relating to the annual rate of magnetic declination, covering the coming decade, and that the observations be tabulated, showing, 1st name of observer, 2nd latitude and longitude of locality, 3rd altitude above sea level, 4th time of observation, 5th annual rate of motion. To these reports each observer should be solicited to add any previous notes taken in his former observations, giving particular attention to dates, locality, etc.

We are occupying our humble place in the world's history, at a time when the line of no variation is sweeping across our prosperous state and the Society will point with pride to its labors in this regard, when that line shall have passed westward of the "mouth of the great Miami river."

The superior quality of the excellent transit instruments made by Messrs Gurley and other reputable makers, affords an excellent opportunity to observe the passage of Polaris across the meridian, and it is to be hoped that many of the Society's members will contribute the result of their observations. Observers should use the utmost care in being certain: 1st that the line of of collimation is parallel with the line passing through the zeros, 2nd that the needle is correctly centered, 3rd that there is no local attraction to interfere. By keeping the instrument in position between 6 A. M. and 6 P. M. the diurnal variation may be noted with considerable accuracy.

DISCUSSION.

The President.—You have heard the paper, gentlemen. Is there any discussion on it? It may be generally known and it may not, therefore I speak of it, that the United States Coast Survey have carried on a series of investigations in the matter of the change of direction of the magnetic needle covering the longest period

for which it is known that any records have been kept, and covering points of the country reaching from the Atlantic to the Pacifiic, I think, or at least as much as they can get. They have published two or three reports on that subject, and they are valuable, and they can be obtained by asking the department for them. There is another point which suggests itself to me by the reading of this paper, the desirability of our always having a true northern line. If the county commissioners of any county in the State of Ohio, or I think, in any other state, will make application for such a line to be established, agreeing to pay simply the expense of locating the line, not the salary of the men sent there to do it, but his expenses while at that point and the expenses of the monuments used to mark the line, and whatever other expenses may arise in establishing the line, the United States Coast Survey Department will, as soon as possible, I persume, or as soon as convenient, send on a man to do that work with instruments that are very superior.

In Toledo such a line has been established. It so happened, fortunately for Lucas county, that the gentleman who established the line had his permanent residence in Toledo, or at least had his home in Toledo. The United States Coast Survey men have no permanent residence, I guess; and consequently all the expense to Toledo was to provide him with carriage hire and assistants in doing the work, the monuments and cost of setting the same, and for a very small sum we have a line very well marked. At the north and south end of the line there is a granite monument four or five feet in length set in concrete two or three feet in depth, and below that is a bottle the centre of the neck of which is set on the exact point so that if the surface should be removed the points could be obtained by taking out the monument and concrete.

Mr. Bowen—Is there anything in the bottle?

The President--There is nothing in the bottle. There is a law in the State of Ohio, I cannot tell you the exact requirements of it, or conditions, but the commissioners of the county are authorized to have the county surveyor make regular observations of the change of the direction of the needle and publish the same in the newspaper, the county paying the expenses. It comes in right along with these suggestions made by brother Dimock, and I therefore speak of it.

Prof. Brown In regard to the last point you speak of,

in regard to the commissioners having a line established, I think it says the commissioners may do so.

The President—They may. They have the proper authority.

Prof. Brown—They may but they won't.

The Chair—They won't unless some one gets after them.

A Member—It appears to me the requirements of that line, a meridian line as specified by the law, requires such fine work that none of the counties are prepared to make such a meridian line, and for that reason the majority of the counties have no such line. The thought you have suggested would give us a reliable meridian line more satisfactory than could otherwise be obtained.

Mr. Burgess—In connection with that subject, I would like to mention to the members that Cuyahoga County has two Meridian lines, one of which was marked out under the statute of the State of Ohio providing for it, and paid for by the commissioners. The other was marked by the Lake Survey, and it is well-known to the gentlemen engaged in that line of business in our section of the country that there is a difference of about thirty minutes between the magnetic variation of those two lines. I was foolish enough to carry a transit from one to the other, to satisify myself that that was so. I have never tried to see whether they are parallel or not.

The President—Are there any local attractions there?

Mr. Burgess—The northern one of them is along the lake shore, and the main tracks of the Lake Shore railroad pass in an east and west direction, or nearly so, and it is nearly at right angles to the tracks, and several hundred feet distant, I don't know just how far.

Mr. Bowen—We have two meridian lines in this county, as they have in Mr. Burgess' county, the one established in the state house yard by Colonel Eads, of the United States Coast Survey, the other is on the Infirmary Farm, three miles south of the city, made by Professor McFarland. With our lines it is about the same as with Mr. Burgess' lines. I have never been able to make the two lines correspond, and I have never known any person who did. There was an effort made at one time to make one line correspond with itself at least, but we did'nt succeed in doing that. Mr. Innis will remember when, I believe, there were six engineers, with six different instruments and each man was perfectly wiliing to swear by his own instrument,

and some of them were "brand" new. We went there and set the instruments up in detail, one after the other and noted the bearings with a magnifying glass as closely as we could, and, if I am not mistaken, there was 60 minutes difference.

The President—That is, the total, of the six amounted to a degree?

Mr. Bowen—No, sir; some instruments varied from the other instruments fully sixty minutes, a full degree. Of course most of them were two or three, or four or five, or perhaps ten minutes apart; but some of them were wide apart, even the best of them. So we did'nt get much satisfaction out of it.

The President—So you don't know whether it was the line that was wrong, or the instruments?

Mr. Bowen—No, sir.

Professor Brown—Did you take the instruments to the other end of the line?

Mr. Bowen—No, sir.

Professor Brown—Professor McFarland has told me about that same line. He took three transits from the University, down on that line, and he could get no two to agree on the south line, and when he moved to the north end he got two sets of readings. The instrument would not agree with itself. He could not make the same instrument give the same result. It is local attraction. That is the way he explained it to me.

Mr. Burgess—I want to say there is one thing I do take a good deal of satisfaction in, and that is that the instrument makers have got to putting their needles under their levels. I wish they would keep them there.

Mr. Sheldon—We have in Medina county a line that, so far as I know, is all right. I have no reason to dispute the accuracy of the line; but it has been several years since I had my instrument set upon it. I lost all faith in it because, I suppose, of local attractions. It is located right in the town. There are houses all along the street and board side-walks, and I could not get the same reading at two points, within fifteen minutes, the last time I tried. I think it is local attraction; but I don't know that that is all the trouble. I would like to know what is the trouble. I have ceased to pay any attention to it. I have not changed the variation of my instrument for four or five years. I am giving myself away, perhaps, but that is what I am doing.

Mr. Colby—In connection with the use of the magnetic needle, I will say that I have not been using the transit at all. I have been depending upon the magnetic needle.

I bought an instrument some twenty years ago, and the needle worked so nicely that I could run a mile and strike a corner within a foot or two. About a year ago the needle got out of whack and I took it to an instrument maker and he altered it, and when I took the instrument back I noticed that the variation of the needle had changed about 40 minutes to the west.

The President—If I may be permitted to say further in regard to the line I referred to in Toledo, it was established by astronomical observations, covering a period, of, I think, at least ten days; or perhaps more, or ten nights. The longitude and latitude of the points were fixed and observations made on the stars by one of the assistants, or sub-assistants, engineers of the Coast Survey department, and when the work was completed, he said he was willing to affirm that the line was within an infinitesimal small quantity of being correct. That is that it was absolutely correct, you might say. It would not vary according to his idea, more than a very few seconds.

Mr. Burgess—At the risk of repeating matter that has been before the association, I would say that Mr. Gurley told me some years ago that once, in his history, he undertook to make three or six needles, and make them alike if he could. And his mechanics did their best to make the number of needles he referred to exactly alike, and put them on the same pivot, and even then the variation was perceptible.

The President—That would enforce what I was about to say in regard to this line. It would seem to be the best thing to first have a correct line established, and then as nearly as possible ascertain the difference of each instrument. Establish and fix the variation for the instrument as well as for the locality.

Mr. Strawn—With this discrepancy that we find in instruments, if it is in instruments,—a half dozen instruments—showing a difference of a degree, the local attractions and the conditions of the atmosphere, etc., the question is whether all these observations, when they are simmered down, are going to amount to very much,—I mean, practically.

Mr. Innis—So far as I am concerned, I use the needle very little. In fact, about all I do is to determine my base line, and the bearing of that base line, and the rest I turn off. If I use a needle at all, I only use it as a rough check in turning off the degrees on the Vernier and I find it gives much more satisfactory results.

Then when I get around, if I find that it proves by the number of sides, angles, minutes, etc., I see I am very near correct. If it don't prove anywhere near, I go back and do it over again.

Mr. Arnett—I find so much irregularity in my magnetic needle that I cannot always tell whether I should rely upon it or not. It is a kind of a renegade. Madison and Union counties got into trouble, and a surveyor was sent out from each side to establish the line, and it was finally dragged into court. Unfortunately, on the part of the surveyors who were sent out, or one of them at least, we got into difficulty, and the court appointed a surveyor to run the line. The speaker was appointed, on the part of Madison, to look after the interests of Madison. Mr. Mowry, of Marysville, was appointed on behalf of Union to look after the interests of Union County. The surveyor, of course, blocked out the work to suit his convenience. He began to run at a point on the Champaign county line, and traced the line eastward, taking such notes as he thought necessary. We will call the top of the map, gentlemen, (illustrating on blackboard) north, and the bottom south. In the place of sweeping a curve out of Madison county, by the instrument being set down each time pointing to the magnetic pole, a curve was swept out of Union county. It took the starch out of me. I expected that we would find a line that would sweep a curve out of Madison; to my utter susprise, it sweeps a curve out of Union. (The speaker here illustrated further from his drawing on the blackboard, and concluded as follows.) It is a good thing to guess by and that is about all.

Secretary Wileman—It occurs to me, in connection with this discussion, to relate a little matter I came across in mine surveying, in a mine near Massillon; and it displays magnetic variations that I have never found anywhere else. In making a traverse in the entries, where the two ends are a hundred feet apart, you will find that they sometimes vary in their magnetic bearing as much as 25 degrees; while the outside bearings will be outside of one or the other of them as much as ten degrees.

A member—Is there an iron track in the mine?

Secretary Wileman—Yes; but sometimes there is only a wooden track; and it is the same everywhere.

Mr Dunn—I made a survey of a coal mine not very long ago. I set up the instrument at the mouth of the entry and took as long a sight as possible in, and took a backsight, and established a point about three hundred feet from the mouth of the mine on a line back in the field, it was north 22 west. I then pulled up the instrument and set on that back station. The reading was

south 32 east, one was north 22 west, and the other south 32 west, a difference of ten degrees in about 300 feet. The one was at the mouth of the mine, and the other about 300 feet away; so I have very little reliance on the needle.

Mr. Hill—In reference to these variations, I want to relate a circumstance that occured to myself once. I was surveying a line and ran a backsight. I found that when I stepped on one side of the instrument and looked at it, it was one way, and going around on the other side, it was a quarter of a degree different. So I began to search for the cause. I had some men around and I had them go away, and I looked, and it was the same thing over again. I studied a good while about that. I had noticed it before. So I began to think that there was something about me that caused it; and I had a hat made like this and right under this there is a steel wire. I put my hat away and tried it and it was all right. After that I never used a hat of this kind when I was surveying.

Mr. Innis—Mr. Chairman, I want to say something in favor of the needle. After we had our records burned in this county, nearly all the towns in the county were re-surveyed and re-platted, and put upon the records again. I went to the town of Reynoldsburg to make a survey, and when I came back, I had a little doubt about it, but I had no time to go back again, and I asked Ed. Kinnear to go. We both had Gurley transits. When we came back and we came to compare notes, there was no bearing that varied more than a quarter of a degree and almost all of them coincided. I think that is the best I ever knew.

DETAILS IN DITCH LOCATION.

BY A. D. SHELDON, WHITTLESEY, OHIO.

At the earnest request of our worthy secretary, more earnest, perhaps, than it would have been, had he known my lack of ability to present anything of general interest to this society, I consented to prepare a paper to be read at this meeting of the Ohio Society of Surveyors and Civil Engineers. Before I proceed, it will be only fair to warn any young member of the society, against accepting and acting upon any of my suggestions without due consideration; and what I may have to say is only meant as suggestive, and, may I hope, helpful,

to some beginner in the work of locating ditches, who, while he may have had far better advantages than came to my lot, to prepare himself, theoretically, for the practice of his profession. yet, it may not be amiss for him to hear some practical suggestions, even from one whose school privileges ended with the high schools of his neighborhood, in which he was only able to obtain a good knowledge of the common English branches, including a tolerably thorough knowledge of algebra, and one term in natural philosophy.

And now to our subject: The first point in the location of a county ditch, which the surveyor, or engineer comes to notice, is upon the "view", by the county commissioners, of the proposed route, under Sect. 4452 of the Revised Statutes, in which the commissioners are directed to take to their assistance a competent surveyor or engineer, if in their openion, his servives are necessary, &c., &c., In making this "view" the engineer will be likely to have an opportunity of consult- with several of the adjacent land owners. and of getting their ideas of the kind and dimensions of the proposed ditch, and to gather from them what their notions are, of benefits to adjacent lands, always locking closely in his own breast, his own opinions, until the great and trying time coming, the "hearing", when he will be called upon for the reason for the faith that is in him. Therefore, I admonish you, have this subject of benefits constantly in mind, whether you are leveling, or going to or from work, whenever awake, and, if you must needs dream, let this same subject of *benefits* occupy your restless thoughts. From suggestions I have received the past season, from observing the practice in an adjoining county, but which has not heretofore been our practice, I would run a preliminary level, at the time of making this view, whenever practicable, measuring the distance roughly, but without setting stakes, and take the elevations of the land surface, and of the bottom of the old ditch or watercourse, which we are supposed to be following, at, say, each 400 feet, leaving plenty of bench marks for future reference. You have now the approximate distance, and a level, to check all future work. If your ditch is to be of considerable extent, say one or two miles, it will pay to go to some neighboring mill or lumber yard, and order suitable stakes, and have them delivered at the most accessible points for future distribution along the ditch.

The grade stakes, or those on which to number the 100-feet stations, should be about 1x2 inches (hard wood is best,)

and two feet long, and with each of these grade stakes, should go three small, hard wood stakes, about 1x1¼ inches, and eighteen inches long, to serve for hub and slope stakes at each station.

Now take with you three assistants, one to assist you in carrying the chain, who should be selected with reference to his becoming an intelligent rodman, one to carry a bundle of grade stakes, and the other to drive them as you shall direct. Take the forward end of the chain yourself, and proceed to carefully measure and "set a grade stake at every hundred feet, numbering down stream" to the outlet, noting the intersections of all laterals, lot or section lines, boundaries of land and owners' names, township and county lines, bench marks and road crossings, and leaving a stake at all angles of the proposed ditch, and noting the distance thereto. You will now have no further use for your third man and he may be discharged, and axman directed to deliver at each station three of the smaller stakes previously provided, one of which he shall be directed to drive, level with the surface, and just inside of each grade stake, to serve as a hub, from which to refer the depth of the proposed ditch at each station. While this work is going on, you will proceed with your rodman to the outlet of the ditch, and proceed to level, taking, 1st, the elevation of the bottom of the old ditch; 2d, the top of the hub, and 3d, the general level of the land at each station, and note these in separate columns, under proper headings, in your level book. With these data you will be able to draw a profile and fix a grade line that will show how much the old ditch will be deepened, and how deep the new ditch will be, at each station.

Having fixed upon a grade, calculate and enter in another column of your level book opposite the number of each station, the elevation of the bottom of the proposed ditch, and head this column "Grade". In the next column, marked "Hub Cut", calculate and note the elevation of the hub above grade. These last elevations are to go into the contract, and govern the contractor in constructing the ditch.

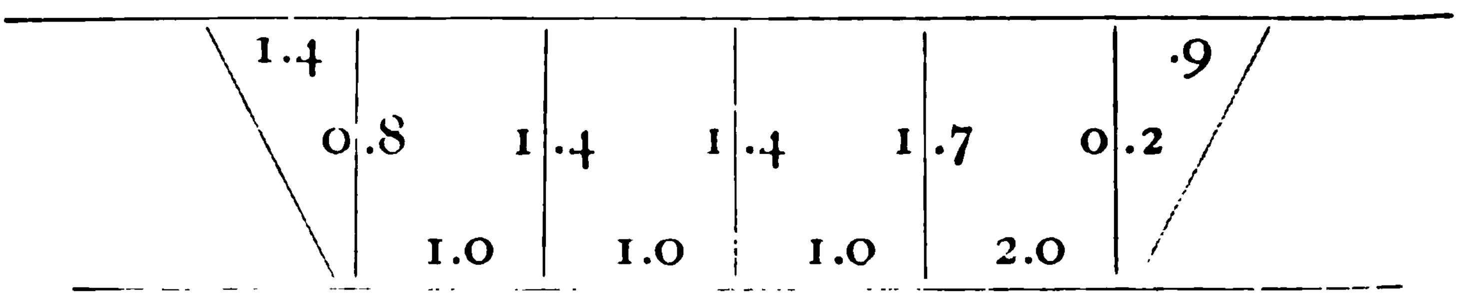
We are now ready to cross-section the ditch, and at this point I expect to meet the opposition of many practical Engineers, who believe that a close enough estimate of the cubical contents in each 100-foot section may be made without this extra labor, but I have never been able to satisfy my conscience, either to my employers, the parties who are to pay for the ditch, nor to the contractor who is to con-

struct it, with this kind of guess work. I have always found plenty of opportunities for cultivating my guessing faculties when I came to fix the ratio of benefits to be charged against the abutting lands for the location and construction of the ditch. For convenience in keeping your cross-section notes, commence at the upper end of the ditch and direct your rodman to set the rod on the hub at station "O", and get your "H. I." above the bottom of the proposed ditch, by adding the rod reading to the elevation found in the column marked "Hub Cut", opposite the number of this station, in your level book. Now take, 1st, the center elevation, 2nd, the elevation to the right or left, at a distance out equal to one half the width of the bottom of the proposed ditch, 3d, find the place for the slope stake and have it driven, and 4th, take any intermediate points necessary to show the contour of the ditch at that station. Do the same for the other side and proceed to the next station, unless, because of irregularities, it may be necessary to take intermediate points, always getting a new "H. I." at each station, as directed in the first instance, thus checking the former hub elevation.

The following example, taken from my field notes of a ditch two feet wide on the bottom, with bank slopes of one to one, is given for the purpose of showing how I calculate the area of cross-section:

			CENTER.			
$\frac{2.4}{3.4}$	$\frac{1.8}{2}$	$\frac{1.4}{1}$	1 | 4	$\frac{1.7}{1}$	$\frac{2.2}{3}$	$\frac{2.9}{3.9}$

To calculate this I make a rough diagram as follows:



This diagram, and the calculations for area, can be made very rapidly, after one has had a little practice.

And now, supposing that at some time during all this work, you have found time to take with the needle the several courses of your ditch, I suppose we ought to be about ready to make our report and plat. But, unfortunately, my conscience will not be satisfied till I have made a survey

of the benefited lands, so as to know, within a reasonable degree of accuracy, how many acres to charge benefits upon, against each land owner to be taxed.

Take with you two good chain carriers, plant your sight pole at some point on the margin of the benefited lands, from which it will be convenient to measure some land owner's benefited land, take your transit on your shoulder and an ax in your hand, and proceed along the margin to the first angle. Set up your transit and direct it on the sight pole left behind, let down your needle and signal your chain carriers to chain up to you, bringing the sight pole with them. Proceed in this way to run the meandering and interior lines of each land owner's benefitted lands, noting all lot or section lines, or other points passed, that may, hereafter be of use in platting and also, leaving a stake at all points to which you will have occasion to return in surveying adjoining land.

It is not expected that these surveys will close so near, but that the surveyor who prides himself, as he should, in the accuracy of his work, will wince somewhat at the results, but if he would wince at these results, after reasonable care, what a face would he *not* make, if he had previously gone out upon some parcel of land and estimated the area by his eye. and noted the result.

You now have data to make a map or plat of the territory included in the improvement. Let the contour lines of the area to be drained be drawn, and the enclosed area colored, so as to show plainly the drainage area, together with the location of the ditch and laterals, lot lines, farm lines, roads, and all matters of interest as a record of the improvement. Draw your map on a scale of not more than six chains to the inch so that the areas of future subdivisions and transfers may be calculated, with a scale, with sufficient accuracy for the purpose of levying taxes for the future cleaning of the ditch.

Such a map will in my opinion be well worth all it will cost, and you will have become possessed of much information necessary in solving that very difficult problem, the apportionment, among the land owners, of the cost of location and construction.

COUNTY DITCH ASSESSMENTS.

BY HOMER C. WHITE, MINERAL RIDGE, OHIO.

The county surveyor is frequently called upon to solve perplexing problems. But of the multitude of questions which will demand his attention, none will arise of a more complicated nature than that of the adjustment or apportionment of county ditch assessments. Nowhere will he be required to exercise better judgment, nor to have a clearer or readier conception of the work before him.

In accordance with the provisions of our statute the duty of apportioning the assessments falls upon the surveyor or engineer in charge of the ditch. Section 4455, Revised Statutes of Ohio defines his duties as follows:

"The commissioners shall also, by their order, direct the surveyor or engineer to make and return a schedule of all the lots and lands and public or corporate roads or railroads that will be benefitted by the improvement, *and an apportionment of a number of lineal feet and cubic yards to each lot, tract of land, road, or railroad* ACCORDING TO THE BENEFITS WHICH WILL RESULT TO EACH FROM THE IMPROVEMENT, *and an estimate of the cost of location and construction to each*, etc."

It is possible that in some respects our laws governing roads and ditches may need revising, but it is our humble opinion that in this instance at least this section (4455) is about as near perfect as it is possible for erring humanity to get it. There was a time when we did not think so. When we received notice that we were appointed engineer to take charge of a proposed county ditch (our first county ditch) we did what all surveyors should do under like circumstances. We began reading law on county ditches. Section 4455 arrested our attention. Evidently the framers of that section had left out something which should be there. "Make an apportionment of a number of cubic yards and lineal feet to each lot, etc., according to the benefits which will result to each from the improvement", was good as far as it went, but it did not go far enough. It did not contain all the information the beginner needed. How am I to determine how much each lot or tract of land will be benefitted? Aye, there is the rub, as many a surveyor has found to his confusion on the day of the hearing. This question safisfactorily answered, the main difficulty in the way of the surveyor is past. Getting no satisfaction from the statute, we resolved to follow a certain course, and if successful after the ditch was completed we would ask senator Reed or representative Strock to take the proper steps to

have the ditch laws amended. Unfortunatly for the peace and happiness of future generations of surveyors the matter did not take the course at the hearing which we expected, but on the contrary, it was clearly shown by the assessed parties, and their attorneys, that the method employed by the surveyor to determine benefits was erroneous. At this point the commissioners kindly came to our assistance and amended our report "so as to make it fair and just."

Humbled, and well-nigh crushed, we resolved to try again before suggesting amendments to the ditch law, and, strange to say, with but little better success, for the same attorneys who, in the preceding case, proved that black was white needed now only to reverse the operation, and, presto white was black. Again the commissioners came gallantly to the rescue. Since that time we have been engaged on a number of county ditches with varying success. You will, however, hardly need to be told that the amendments proposed to be offered by us were never adopted. We discovered that no special rule could be made which would apply to all cases; that the only common similarity existing between county ditches was the dissimilarity of each to all the others, and that the very best which could be done, under the circumstances, was what had already been done — a general rule covering the end for which the improvement was to be made, namely: Benefits to the property owners.—The matter as to how benefits shall be determined being left to the jugdment of the engineer, subject to revision by the commissioners after the hearing.

Our aim in presenting this subject for your consideration is the desire that the younger members of the profession may receive the benefit of the experience of the older members. We would rejoice to have this question thoroughly discussed. Would be glad also to hear how the younger members of the profession dispose of this work. If you cannot tell us of great victories, tell us of your failures. The buoy and the beacon are alike signals of value to the mariner. If you cannot tell us where you have found deep water and smooth sailing, tell us where you have struck a hidden rock.

As already suggested we believe it would be very unwise to burden the statute with instructions to surveyors upon methods of determining assessments, however, there is no reason why surveyors themselves should not exchange views and ideas.

Our plan of late years has been about as follows, with slight modifications as the case seemed to demand:

The number of acres that will be benefitted by the improvement are classified as follows:—

First Class—Swamp land No. 1.
Second Class—Swamp land No. 2.
Third Class—Low land.

Swamp land No. 1 includes all submerged lands and such lands as are a total loss to the owner thereof by reason of the water standing thereon.

Swamp land No. 2 includes a higher or firmer grade of swamp land capable of being pastured during dry seasons.

Low land includes flat timber land and cultivated lands along the borders of the swamp and which are subject to overflow in times of high water.

The grade line of the ditch being established, it then becomes necessary to determine what benefit the ditch will be to each tract of land assessed. This may be done as follows:—

Mr. A is assessed for twenty acres of swamp land No. 1, which is worth nothing to him in its present state; but when drained this land will be worth $20 per acre or $200 benefit on the twenty acres.

Mr. B is assessed for fifteen acres of swamp land No. 2, estimated, in its present condition, to be worth to him $20 per acre; but, if thoroughly drained, would be worth to him $50 per acre, making $30 per acre, or $450 benefit derived by B from the opening of the ditch.

Mr. C has eighteen acres of low land on the edge of swamp which is covered by timber. Value of land per acre, with timber, $50; when drained the property will be worth $53 per acre, or $54 total benefits to C.

Mr. D has twenty-six acres of low land similar to Mr. C's land, except that it has been cleared and an attempt made to cultivate it. Value of land, at present, $20 per acre; valne when drained, $40 per acre, or total benefits derived by D $520.

Total benefits arising from construction of ditch, $1,224. Estimated cost of ditch, say, $1,000; then we have by proportion: A's assessment: $200 :: $1,224 : $1,000, hence, A's assessment equals $244.80.

DISCUSSION.

The President—Mr. White invites the members of the profession who have had experience in that line to relate their experience, especially the younger men. It is now open for discussion.

Mr. Walker—I guess I have been in the same box several times. In the last three years I have been county surveyor, I

ave had twenty-six ditches ranging from two to four miles. This iethod of low land and swamp land is one I usually follow, but 'e have generally high ground running down water on the low round. A difficult matter for me is to get the right assessment ı the high ground. It wont benefit their land to have a ditch iere and yet they run their water down on this low land where ie ditch will benefit the land. My trouble is to make the assess-ient on the parties who own the up-land.

A member—I will ask the gentleman if he assesses a man 'ho is not benefited, whether the law will allow him to do that?

Mr. Walker—I always do, and I have never had a kick. I iink it unjust and unfair, if one man's farm is sixty or seventy ›ds from the ditch and drains all this water down on the low .nd, that he should not pay part of the expense.

Mr. Sheldon—I have come to believe that this man who owns ie high land does not run the water down there; that it was the 'reator who put it in shape to run down, and that it has a right › run down; and so the man who owns the land below should ot have bought this land, knowing that the water would run own from the up-land.

Mr. Gormley—In Seneca county we have usually ten, twenty-ve and sometimes thirty-five county ditches in a year. We assess ie high lands, provided that the natural water courses leading 'om the high parts down onto the low lands have been improved; nd I think you will find that supreme court decisions sustain this iethod. The supreme court has decided in several cases that 'here these natural water courses have been improved and not ·ft in their natural state, you can assess them; that is where ie water on the higher land has been collected in a volumne and rained down on the lower land; but, if the land is in its natural :ate and no improvements have been made, I don't think it iould be assessed.

Mr. Walker—I have a ditch now in construction and I can ·ace that ditch when it was not over three feet wide and they aised as good crops then as now, when it is tweuty-two feet wide. 'he higher land is tiled and it is drained into Muskingum county ›r four miles square. It has been drained for fifteen years into iat county, and it necessitates the construction of a larger ditch nd for that reason I assess the higher ground.

Mr. Strawn—The older members of this society will remember hat Mr. Opdyke, of Bryan, was requested to prepare some re-›orts in regard to just apportionment of assessment on county itches. Those reports of Mr. Opdyke I think were continued

... The report was also published in
... our reports. I have found
... country there are no county
... these reports published by this
... of attorneys and law-suits
... of Mr. Opdyke, he being
... and I would refer the mem-
... the reports of Mr. Opdyke.
... assessment, I think that a supreme
... has been rendered which will
... contiguous lands that were not
... it, was that of a man having
... occasioned by springs coming from a
... all this ground and made it valu-
... and discharged this water on
... low lands below him, and the
... of water brought suit to re-
... Court decided that the gentleman
... a right to drain this water to any
... might see fit; so long as it was not
... had a right to discharge it on his
... a point on his own land and dis-
... and it was sustained.

... case of this kind in our county last
... went upon the ditch on a view
... should be allowed. The petitioner
... claiming that, as all this land was
... the assessment should go to the
... to bring Mr. Opdyke's paper.
... so good as to hear it all read through.
... reading, and after the reading of
... set aside. This man didn't want ...
... his up-land neighbors to help pay for it.

... second Mr. Strawn's suggestion and
... Opdyke's paper. I remember hearing
... of them were very interesting, and after
... to the conclusion that Mr. Opdyke had
... all that we needed upon the subject.
... got at that time. Of course new cases
... and lead to new ideas, but the most dif-
... assessment according to benefits ... to de-
... lands gradually terminate in high ground.
... out, figuratively speaking. We see low.
... we know that is benefited by drainage. Then

we come up to the high land, a little higher grade, as Mr. White fixes it, and then another grade that shall be assessed at another figure. This is all imaginary, but it is the best the surveyor can do. There is no well-defined line by which we can define the particular grade. As we go up on higher ground, it might be that some land would not be benefited at all, but, as a rule, I think engineers have been assessing upon the territory, high and low, in reach of the ditch, upon the general principle that a ditch that drains low land was a benefit, if in no other way, in a sanitary way, to the man who owned high land. You may say there is a certain amount of obligation that the man living at the top owes to the balance of the people, but he cannot be assessed much. Of course the high ground is always assessed the lightest and he ought not to complain. Mr. Sheldon's idea I believe was that the man on the high ground got his title from the Almighty. Well now, that is very true, but isn't he responsible as tenant? The only difficulty I see for the engineer is in grading it satisfactorily. He needs to have good judgment — some experience and good judgment, and do the best he can, and as a rule, that kind of judgment is the best that can be applied in such a matter. I think probably Mr. White's plan would come as near exact justice in dealing with that kind of a case as any other, and if that is followed out you will not miss the mark in any case very much.

ARTIFICIAL STONE IN CONSTRUCTION.

BY SAMUEL BACHTELL, COLUMBUS, OHIO.

In treating the above subject I will not attempt to give the members of this society any learned article composed of and bounded on all sides by theory, but rather believing and hoping that each member is a practical worker in whatever special branch he may have chosen, and that for mutual benefit we meet annually to exchange experiences as well as to transact other business beneficial to the organization, I will at once proceed to relate when, where and how I have used artificial stone in construction of a canal lock wall.

During the summer of 1889, and while I was Chief Engineer of Public Works in Ohio, the left hand wall of the second lock from upper end of the flight of locks, on the Ohio Canal at Lockbourne required to be rebuilt between head and tail walls, sixty feet in length six feet in thickness and ten feet in height.

The original construction of this lock was rather out of the usual order; the dimensions as to length, width and other details were of the usual size, and construction, excepting the part above mentioned in each wall. This part had a low wall on each side about three feet in height, and from this wall the earth sloped away at an angle of about 45° and the surface was faced with rip-rap. On the whole length of this low wall rested a wooden frame, and the top covered with plank of same elevation as lock walls and covering space caused by the sloped banks and which it joined.

Some yielding of the soft sandstone upon which the framework rested caused the framework, platform and the rip-rap of of the side to fall into the lock.

Of course the first thing to do was to remove the debris and restore the former or some other conditions of the lock that could be done the quickest and at the same time economically. The wall to be restored, if done with stone, would require 133 cubic yards.

Stone not being an article on the market ready dressed, but has to be dressed especially for each case, and considering the time required to dress the stone, and that quantities of masonry as small as this could not be done by contract for less than $8, and possibly $10 per cubic pard, I at once determined to restore the wall with artificial stone.

The cement used was Louisville black diamond of fair quality, the sand was of an inferior quality, and suitable gravel could not be secured near the locality; I was therefore forced to use sand and cement alone.

The proportions that I used were as follows—Cement one part, sand two and one-half to three and one-fourth parts.

The sand was first measured and thrown into an ordinary box like those used by plasterers, and the cement thrown on top, two men with hoes thoroughly mixed the same dry. Water was then slowly added through a sprinkler from a common watering pot, while the mixing with the hoes continued until the entire mixture was damp and most thoroughly mixed. The test that I used for dampness was when sufficient water had been applied to cause the mixture to be of a pasty nature, so that when a handful of the mixture was taken up in the hand and firmly pressed would cause it, when the hand was opend, to form a body that would rest on the hand without falling to pieces if too dry, or run like a semi-fluid, if too wet.

I had scantling fixed at the bottom of the lock wall on the inside and on top and outside of the low wall upon which the

new structure was to be built. The scantling were held in place at the top by a detachable piece of timber that would admit of removal. On the inside of the scantling were two-inch dressed plank to give form to the wall.

The lock not being required to sustain any super-incumbent weight, but on the contrary the pressure being lateral, so after having constructed a bottom six inches thick on the top of the low rough wall, I determined to construct the wall with openings in it for the sake of economy. I therefore constructed it in the following manner:—The front wall fourteen inches in thickness, the rear wall ten inches in thickness with six openings four by six feet in the interior, separated by cross or tie-walls ten inches in thickness, uniting the front and rear walls.

The plank giving the form all being in place, and the material having been mixed as above described, was now evenly spread over the surface about two or three inches in thickness and rammed with especially made cast-iron rammers until solidified. Should any surface become dry before another thickness was to be added it was well sprinkled in order that there might be a perfect union between the old or hardened and the new material just being applied. The plank used for the forms were from time to time removed and raised to correspond with needs of the advancing work. The face wall was given a batter of six inches in ten feet. The open spaces in the wall were filled with the stone of the fallen rip-rap wall broken up small and filled in with an inferior gravel, and all well rammed and compacted.

The wall was finished with a layer of artificial stone six inches in thickness. When this had thus far been completed, I had the scantling and forms removed, the water turned on and navigation resumed. So firm did the material become that in a few minutes men could walk over the new material during construction without leaving any indentations, and in about an hour water thrown upon the top of the wall ran from the surface unstained, showing that the action of solidifying had already been well advanced.

This work, a monolithic wall, was the result of experiments that I had been conducting with cement and sand during several years previous to this time, and was constructed without the aid of skilled labor; of course I instructed the workmen at first in every detail, but when they understood the process I left them under a foreman to carry on the work, inspecting the same from time to time during the week that was required in construction. The entire cost of removing the debris from the lock and constructing the wall was $528, as in contrast to the opposite wall which, under precisely similar conditions, had been renewed with stone some ten years before at a cost of $1,000.

WIDTH OF PAVED ROADWAY IN CITY STREETS.

BY S. WHINERY, CINCINNATI, O.

NOTE: — This paper, in nearly its present form, was presented to the Engineers' Club of Cincinnati, and read at the August, 1891, meeting, and is offered for reading before the annual meeting of the Engineers' and Surveyors' Association of Ohio, by request of several members of that association.

The most serious obstacle in the way of securing well paved streets in all our cities and towns, is the great cost of such improvements, and the unwillingness of the people to bear the burden of taxes and assessments necessary to pay for them. It is, of course a fact that such burdens are rather fancied than real, since in nine cases out of ten, a well paved street is a good business investment for the property owners along it, but it is very difficult to get the average citizen to see it in that light; and while he can but admit that well paved streets are a blessing, he usually regards the collection of assessments for such improvements an infringement on his liberty, or a species of legalized confiscation of his property.

It being universally admitted that well paved streets are,—barring the fact that they must be paid for,—desirable, and in fact necessary for the comfort of urban residents, it becomes an interesting problem how to reconcile the warring elements of cost and comfort, or in other words, how to secure well paved streets at a reasonable cost.

Unfortunately good pavements of whatever kind, like most other good things, are expensive, and the property owner is not generally able to withstand the temptation to favor an inferior article because it is cheap. As a consequence, few cities have escaped the curse of miles of socalled pavements constructed in the shabbiest manner out of the poorest materials, having no other virtue than low first cost, but proving in the end so expensive, that only the wealthiest communities can afford them.

As one possible solution of the problem, how to secure well paved streets at a reasonable cost, the possibility and propriety of reducing the width of the roadway is suggested. Most of our American cities and towns have been laid out with streets of liberal width. This is particularly true of those parts of cities devoted to residence purposes. Wide streets are desirable for the free admission of air and light, and for their æsthetic effects. But the primary and principal function of streets is to afford means of intercommunication between the different parts of a city, and aside from the considerations named above, the width of any street should be determined by the requirements of such in-

tercommunication, or in other words, by the amount of travel it is required to accommodate. Judged by this standard, any observant person must admit that the majority of the suburban and residence streets of our cities are unnecessarily wide. Viewed from this standpoint, it seems preposterous to provide a pavement forty or fifty feet wide to accommodate the few light and infrequent vehicles of the residents, and the occasional trips of the milk, ice and grocers' wagons that supply the people with the necessaries of urban life.

The question will naturally arise, why not, while securing the benefits of wide streets, make the paved portion of them conform to the requirements of travel?

Quite extensive observation has convinced the writer that a roadway from eighteen to twenty-four feet wide is ample to accommodate the travel that passes over the great majority of residence and suburban streets in American cities. There are, of course, in every city, a number of principal roads or driveways where wide roadways are necessary, but if one will consider the matter he will be surprised at the small number of such heavily travelled streets outside the business portion of any given city; and if he will take pains to observe the amount of travel passing over streets other than such main arteries, he will be surprised at the smallness of its volume.

It may be stated as the average practice in American cities, to make the roadway three-fifths of the total width of the street. This gives for a sixty feet street, a roadway thirty-six feet wide, and it is customary, when the street is to be improved, to have the whole width of this roadway paved, regardless of whether it is or is not necessary to properly accommodate the travel to which the street is to be subjected.

It seems to the writer that this practice is a needless extravagance and a waste of public funds. In the case of at least four out of five such streets, not principal driveways or popular boulevards, a paved roadway eighteen feet wide will be found amply sufficient to meet all the requirements. The arguments in favor of reducing the roadway width on such a street from thirty-six to eighteen feet may be briefly stated as follows:

1st. The first cost of paving the street is reduced one-half; and because of such reduction, it will be found easier to get the property owners to consent to the construction of a first-class pavement.

2nd. The cost of cleaning or sprinkling the street is reduced one-half, or, in case it is not cleaned, there is only one-half the

surface to supply dust and dirt to be carried into the houses by the wind.

3rd. While the cost of maintenance and repairs might not be reduced in proportion to the width, since such cost in the case of pavements not subject to natural decay is a function of the amount of travel over them, there can be no doubt that the cost of such maintenance and repairs would be greatly reduced.

4th. The narrow pavement leaves a wide space on each side of the street, which, after providing for ample sidewalks, may be sodded with grass or planted with trees, thus greatly increasing the beauty and comfort of the street, and practically adding to the front depth of abutting lots.

5th. There will be ample space between the curb and the sidewalk in which to lay all sewer, water and gas pipes, where they will be readily accessible for repairs without cutting into and disturbing the paved roadway.

This is a most important consideration, which I need not discuss in detail. As this plan contemplates placing a line of such pipes on each side of the street, it may be claimed that the cost of such pipes would be doubled. This would not be true, since not only would the pipes for the double system be smaller and cost less to lay, but the house connections would all be materially shortened, and their cost reduced, and the saving on the large number of these connections would probably more than balance the extra cost of the double lines of pipe.

6th. A paved roadway eighteen feet wide will allow two lines of vehicles to meet or pass each other freely. It is objected that teams could not be turned round in such a street. This is admitted (though it is not impossible for a skillful driver to turn a one-horse vehicle in a street eighteen feet wide between curbs), but if circular curbs, say of twelve feet radius are used at the corners, there will be ample room to turn at the street intersections; and even if drivers found it necsssary to go around a square to make the turn, it would not be a serious inconvenience.

These advantages, and the great economy that would result from the adoption of the plan, make it worthy of more careful consideration than it has heretofore received.

Many people who habitually oppose innovotions, whether they are meritorious or not, will resist the making of such narrow driveways, simply because it is not the "good old way." But if the plan is found to possess the merits claimed above, and no more serious objections to it appear, than now occur to the writer, it is certain, like all other meritorious things, to be adopted in the end.

It is not, of course, claimed that the idea is new, or that it originated with the writer, but it has not heretofore received the attention it deserves, and it is with the hope of securing such attention and a full discussion of the subject, that this paper is presented.

THE MUSKINGUM RIVER BRIDGES.

BY T. C. CONNAR, ZANESVILLE, O.

The bridging of rivers and smaller streams dates back to a time when Babylon was in the height of her glory, and perhaps farther into the forgotten past. But the bridges spanning the Muskingum river are of a more recent date. The first of the twenty-three bridges across the Muskingum river was commenced in 1831 and was completed in the following year. It is known as the Main street bridge, Zanesville, Ohio, or the Y bridge. It is well named the Y bridge, for this reason, that it divides in mid stream, one branch, or fork, of the bridge, reaching the west bank of the river above, and the other below the mouth of Licking river. The sub-structure is built on solid rock. The rock extends across the river, and at no place is it more than two or three feet below the surface of low water. The pier at the junction of the stem and branches of the Y are very large and of a peculiar shape, and is built with only outside courses of masonry; the center of the pier never having been filled. The superstructure is constructed of wood. It has a double roadway, 12 feet each, and two sidewalks 4 feet each. The trusses are the Buckingham design. The roadways are separated by a center truss. The bridge is covered and sided up about five feet above the floor. The bridge is in good condition after nearly sixty years of service. It consists of 3 spans to the center of the river, one of 65 feet and two of 154 feet each. The up stream branch has 3 spans of 90 feet each, and the down stream fork has 2 spans of 114 feet each. One peculiarity of the bridge is this, you can cross the bridge and still be on the same side of the river.

During the erection of the superstructure in August 1832, the second span was carried away in a freshet, before the span was swung. Judge Buckingham, father of the designer of the bridge, was killed by the falling of the span.

The second that was built across the river was the Third street bridge, connecting Zanesville with Putnam, now the Ninth ward of

Zanesville. It is the same style of truss as the Main street bridge. It has a double roadway, 11.25 feet each, and one sidewalk 4 feet wide. A center truss divides the right and left roadways. The bridge consists of 5 spans, 109 feet each. It was erected in 1833. It was partially destroyed by fire in 1845, and rebuilt on the original plan in 1846. Being a covered bridge the timber is in a good state of preservation. The trusses and floor system are much lighter than the Y bridge. The sub-structure is built on solid rock, and as the rock is very close to the surface of the water it enabled the builders to secure a good foundation without much trouble or expense.

The next in order is the B. & O. R. R. bridge, it being the first iron bridge constructed across the Muskingum river. It was built in 1852-3. It crosses the river just above the Y bridge and below the State dam. The sub-structure, like the Y and Third street bridges, rests on solid rock a short distance below the surface of the water, and consequently foundations were easily obtained. It consists of 4 spans of 127 feet each, the trusses being constructed on the Bollman plan. The bridge was designed for a double track, but on account of the lightness of the trusses and the increased weight of rolling load, it is used at the present as a single track bridge. Owing to the low capacity of the bridge the railroad company have placed a wooden Howe truss helper on the inside of each truss. In 1866 the west span was broken down by overloading. One life was lost by the wrecking of this span.

About the year 1854 the suspension bridge at Dresden was built. The clear span between the towers is 410 feet. The bridge is supported by eight three-inch wire cables. The roadway is 18 feet wide. The stiffening truss is only about 3½ feet high, and consequently, there is a great amount of vibration, especially if the wind is blowing very strong.

The C. & M. V. R. R. bridge at Zanesville was first built about 1859. It crosses the river at an angle between the Y and Third street bridges. The foundations are on the same strata of rock as the B. & O, the Y and Third street bridges. It consists of 4 spans as follows: Two of 149′¼″ each, one of 133′4¼″ and one of 141′4¼″ c to c of end pins. It was originally built as a wooden Howe truss. Two years ago two spans were renewed with iron Pratt trusses, and last year the remaining two were rebuilt with the same style of truss. To obviate the skew angle and bring the panel points at right angles to the center line of the bridge, the trusses are built with one plumb and one inclined end post.

The B. & O. S. W. R. R. bridge at Marietta was built in the early 60's. As originally constructed it was a wooden Howe truss, consisting of 3 spans as follows: One of 160, and two of 190 feet each, and one swing span of about 138 feet. The approach on the west is a wooden trestle 70 feet long and 150 feet of wooden trestle on the east side. The two 190 foot fixed spans and the swing span have been replaced with iron Pratt trusses. The 150 foot span will be replaced with a swing span, as the United States government has changed the locks from the west to the east side of the river. This span will be rebuilt as soon as it is decided whether the government or the railroad company will have to pay for the rebuilding, as it will necessitate a change of the adjoining span to fulfill the requirements of the law giving two channels 80 feet wide at low water. The sub-structure is built on pile foundations. The pivot pier consists of two parts, viz: A small pier in the center, on which rests the pivot, and an outer ring on which the track is fastened.

The McConnelsville highway bridge was built about the year 1866. It is a covered wooden bridge of the Buckingham type of trusses strengthened with an arch. It has 3 fixed spans of 127 feet each, one roadway 16 feet in the clear and one sidewalk about five feet wide. It also has a swing span about 129 feet long of the Howe truss type; the outer ends of the span being supported by hog chains over a center tower. The masonry was built in an open top caisson, and sunk to the bed of the river. No excavation having been made under the caisson, a part of the sub-structure has settled out of plumb.

About the year 1870 the C. & M. V. R. R. bridge at Ellis' station was built. It has four Howe truss deck spans of 132 feet each. Cofferdams were used in securing the foundations of the sub-structure.

The highway bridge at Taylorsville was built in 1874. The location of the bridge is about 250 feet below the dam. The foundation of the sub-structure is solid rock, which, at low water, is exposed in a great many places. The superstructure is the Smith type of wooden trusses, consisting of 5 spans of 160 feet each. The roadway is 16 feet wide having a capacity of 80 pounds per square foot. It has one sidewalk suspended on the outside of the truss. The bridge is sided up and covered with shingles. The superstructure and piers were carried away by a flood in 1884. The piers were moved bodily down stream without wrecking the masonry. The bridge was rebuilt the same year on the original plan.

The bridge at Hammondsville was built in 1876. It is a

wooden bridge of the Smith design. It consists of two spans of 190 feet each, having a 16 foot roadway. It is sided and covered.

The bridge at Moore's crossing was built in 1876. It is a covered wooden bridge consisting of two spans of 175 feet each, having a 16 foot roadway.

The Fifth street bridge, Zanesville, Ohio, was built in 1878. It has 4 spans of 140 feet each and one of 52 feet. The piers were built in open top caissons and grounded without excavating any material in the bed of the river. The grillage in the bottom of the caisson rests on sand and gravel. The four 140 foot spans are of wood of the Smith design, and the 52 foot span is an iron pony truss. The roadway is 20 feet between trusses. It has one sidewalk 4 feet wide. The bridge was never covered and is in a very bad condition. This bridge is being replaced with a new steel bridge a short distance below the present one, which will be described in the proper place.

The highway bridge at Marietta was first built in 1880, and was a wooden truss of the Smith design, consisting of 5 fixed spans as follows: One 75 feet, one 120 feet, two of 155 feet each, one of 194 feet and one swing span of 129 feet. The roadway was 17 feet in the clear, between trusses. It had one sidewalk 6 feet wide. The swing span, the only one remaining of the original bridge, is a Howe truss. The outer ends of the swing are held in position with hog chains, passing over a tower between the two arms of the draw span. One peculiarity of the bridge is that it was built with two pivot piers, so that the draw might be changed from the west to the east side of the river. At present the draw is on the west side, but in a few weeks it will be changed to the east side, and will take the place of the 194 foot span. The superstructure, with the exception of the swing span, was washed away by a flood in 1884, and has been replaced in the following manner: The east and west shore spans are very light iron Pratt trusses, the 194 foot span and the two 155 foot spans are combination Pratt trusses; the top chord, inclined end posts, and panel posts are wood; the bottom chords and diagonals are iron; the diagonals and bottom chords are pin connected; the connection of the diagonals and top chord is made by means of a screw; the foundations for the sub-structure are made of piles sawed off some four feet under the surface of low water, and a platform or grillage sunk by the weight of the masonry on to the top of the piles. The dam across the river washed away in 1891 leaving some four or five feet of the piles out of the water during the past season.

The highway bridge at Beverly was originally a covered rooden bridge of the Smith design, consisting of four fixed spans, s follows: One span of 55 feet, one of 75 feet, two of 170 feet ach, and one swing span of 129 feet. The roadway is 18 feet in e clear, between trusses, and one sidewalk 6 feet wide. The ridge has always been an obstruction to navigation, both on acount of its location with reference to the currents, and the draw ot being of sufficient width for boats to pass through without anger of being wrecked, and especially if the water was high. 'he United States government required the county commissionrs to lengthen the draw span from 129 to 192 feet. During the ast season the change was made by placing a new draw in poition. The swing span as rebuilt is a steel Pratt truss with a ower in the center, having suspender eye bars reaching from he top of the tower to the hip formed by the inclined end post nd top chord. In making the change about 27 feet were taken ff the adjoining 170 foot span and 37 feet off the 55 foot span.

The sub-structure was built on timber foundations. The iers were built in an open caisson and sank into position. The bottom of the caisson rests on sand and gravel. No dredgng or excavation being made so that the grillage would come to level bearing. The courses of stone were leveled at the surace of the water making the masonry appear perpendicular. This bridge was built in 1880.

The highway bridge at Lowell has three spans of 155 feet ach with a 16 foot roadway. It is a covered wooden bridge of he Smith design. The river is not navigable at this point, a anal having been constructed at some distance from the river, a raw was not required. The canal bridge will not be considered s a part of the bridge. The foundations of the sub-structure vere secured in the same manner as the Beverly bridge. It was uilt in 1880.

The Stillwell Ford bridge was built in 1881. It is a Buckngham truss, consisting of three spans of 155 feet each, and has 16 foot roadway. It is covered and sided. The foundations of he sub-structure are timber. The water being shallow coffer lams were used for the construction of the foundations and piers.

In 1884 what is known as the Sixth street bridge, Zanesville, Ohio, was built. It is a Pratt truss with parallel top and botom chords. There are four fixed spans of 150 feet each, one of ;o feet and one of 29 feet, and a swing span of 150 feet, one arm xtending over the canal. The bridge has one roadway 22 feet vide in the clear, and two sidewalks 6 feet each. The capacity of the bridge is claimed to be 100 pounds per square foot of floor

surface, the factor of safety being four. The roadway joists are of wood laid on top of the iron floor beams. The foundations for the sub-structure were made of timber. Cofferdams were used in the river, the water being only from one to three feet deep. The excavation for the foundations was made from three to five feet below the bed of the river. The superstructure was buitt by the Columbia Bridge Co., of Dayton, Ohio.

The Gaysport highway bridge was built in 1886. It has three fixed spans of 150 feet each, and one swing span of 140 feet. As originally built the three fixed spans were wood of the Smith design, The swing span is a Howe truss with hog chains over a center tower. The three fixed spans were blown down by a storm in 1887 and were replaced with iron Pratt trusses having a capacity of 1,800 pounds per lineal foot of bridge. The sub-structure is built on timber foundations. Cofferdams were used in the construction of the foundations of the piers. A wooden crib filled with stone extends up stream about 60 feet and down stream about 40 feet from the pivot pier, and is 16 feet high above low water. The water in the river at this point is only about 4 feet deep.

The Stockport highway bridge was built by the commissioners of Morgan County during the years 1890 and '91. It is located a short distance above the dam. The foundations of the sub-structure, except the pivot pier, are constructed of timber. The pivot pier is built on a pile foundation. Cofferdams were used in making the excavation and building the piers. The excavation for the piers was carried down to a point about 22 feet below the surface of low water. The foundation platforms were constructed of two courses of timber overlaid with plank. The timber foundation rests on sand and gravel. The excavation for the foundations of the piers was carried down some 7 or 8 feet below the foundation of the dam, thus making it practically secure in the case of a scour in the bed of the river. The superstructure consists of two fixed spans of 235 feet each, aud one swing span of 165.25 feet. The arms of the draw span are unequal, the shore arm is 68 feet long while the channel arm is 97.25 feet. The superstructure is an iron Pratt truss. It has one roadway 18 feet wide in the clear. The height of the truss is about 33 feet, capacity 80 pounds per square foot on roadway. The floor joists are wood placed on top of the floor beams. The superstructure was built by "The King Iron Bridge & Mfg. Co.," of Cleveland, Ohio.

In the spring of 1889 the writer was employed by the commissioners of Muskingum County to make the necessary surveys,

maps, plans and estimates for three bridges over the Muskingum river, one at a point five miles below the city to be known as the Brush Creek bridge, one in the city of Zanesville at or near Monroe street and one ten miles above the city. The plans for two of the bridges were submitted to the secretary of war and were approved. The contracts for the Monroe street and the Brush Creek bridges were let late in the fall of 1889.

The Brush Creek bridge has two fixed spans of 180 feet each and one swing span of 194 feet c to c of masonry. It has one roadway 16 feet between trusses, having a capacity of 1,280 pounds per lineal foot. The two fixed spans are Whipple or double quadrangular trusses, 178 feet c to c of end pins divided into 11 panels, height of truss 28 feet. Roadway joists are 7 inch steel I beams fastened on top of the floor beams.

The swing span is constructed of two Pratt trusses 88.5 feet c to c of end pins, connected to a center tower, the end pins of the bottom chord gripping the base of the tower. The top of tower is connected with the top chord at the hip with suspender bars. The superstructure was built by the Smith Bridge Co., of Toledo, Ohio.

The foundations of the structure are as follows: In the east abutment piles were used with three feet of concrete on top of the heads of the piles.

Pier No. 1.—Piles were driven, sawed off level and capped with 12"x12" square timber and drift bolted. The space between the caps was filled with concrete to the top of the caps, then a course of 12"x12" square timber laid close together and drift bolted to the caps and this overlaid with 3 inch plank spiked down on the timber.

Pier No. 2 is on a timber platform constructed of two courses of 12"x12" timber overlaid with 3 inch plank.

No. 3, the pivot pier. 1st.—Piles were driven and then capped with 12"x12" square timber. 2d.—12"x12" square timber was placed across the caps over the piles. 3d.—All spaces between the timber up to the top of the second course of timber was filled with concrete. The west abutment foundation was constructed the same as pier No. 1. Cribs were built at right angles to the center line of the bridge extending 100 feet up and down the river from the pivot pier. They are about 28 feet high. They are built of white oak timber 12"x12" square, drift bolted together with 7/8" square bolts 30 inches long. After the cribs were built, they were filled with stone. The depth of water at this point is from 8 to 10 feet. Coffer dams were used in the construction of the foundations and piers. The bed of the river is sand and gravel.

The nose cf the starling is protected with wrought iron plates 16 inches wide and 3/8″ thick connected with an angle iron 4″x4″x½″ firmly riveted together and extending from 3 feet above high water to the foundation.

The Monroe street bridge has three truss spans, two of 160 feet each, and one of 265 feet c to c of masonry. The approach on the west side of the river is over low bottom land and consists of 116 feet of iron and 816 feet wooden viaduct, making total length of bridge and viaduct 1,517 feet. The water in the channel of the river is from 12 to 15 feet deep. The bed of the river is composed of sand and gravel, which extends 50 feet below the surface of low water. The excavation for the foundations of the piers was carried down from 5 to 12 feet below the bed of the river. The foundation platform of all the piers were constructed of two courses of 12″x12″ square timber drift bolted together and overlaid with 3 inch plank securely spiked with 8 inch spikes. The foundation of the abutment was made of concrete 3 feet thick. Cofferdams were used in the construction of the foundations and piers located in the water. The large piles and shut piles were from 25 to 32 feet long. The spaces between the walls of the dam were filled with clay, sand and gravel and averaged 10 feet in width. On account of the frequent high water during the year 1890 the contractor had a great amount of trouble to keep the dams in a condition so that the work on the foundations could be successfully carried on. The top of the coping of the channel piers is 50.5 feet above the water, giving a clear height of 50 feet from the lowest point of the superstructure to low water, as required by the law governing the construction of bridges over the Muskingum river. The two 158 foot spans c to c of end piers are Pratt trusses, having parallel top and bottom chords. There is a grade on these two spans of 5.25 feet in the length of the span. The chords are placed level and the grade is made in the floor system by riveting the floor beams at the required height to the panel posts. The channel span is 261 feet c to c of end pins. The design of the truss is a half hitch, the top chord being divided into three sections as shown by the drawing. The bridge has one roadway 22 feet wide, and two sidewalks 6 feet each, in the clear. The floor joists are built I beams, 15 inches deep, weighing 49 pounds per foot, riveted between the floor beams, so that the top of the joists is level with the beams. No wood spiking pieces are used on top of the josts. The floor is fastened to the joists with hooks, one end driven into the edge of the plank and the other hooking around the flange of the joist. The capacity

of the bridge is a uniform distributed load of 3,400 pounds per lineal foot, using a safety factor of four. The trusses, beams and joists are mild steel.

During the summer of 1890 the writer was employed by the commissioners of Muskingum County to make a survey, maps, plans and estimates for a new bridge to take the place of the present Fifth street bridge, Zanesville, Ohio. The United States government previous to this had notified the county commissioners to remove the bridge as it was an obstruction to the navigation of the river. Two plans were prepared and submitted to the secretary of war. One was for a low bridge with a draw in the center of the river. The other a high bridge about 200 feet below the present bridge. The plans for the high bridge were approved by the war department, The contract for the high bridge was let in the winter of 1890, and construction began in the spring of 1891. Cofferdams were used in the construction of all the foundations located in the river. Cofferdam for pier No. 1, west side was constructed of 8"x8" square timber driven as piles, the cracks battened and canvas fastened on the outside. The excavation was carried down to rock 20 feet below the surface of the water. This was the only place rock was found, as soundings were made to a depth of 40 feet and no rock found. Cofferdam No. 2 was made of 8"x8" timber, bolted together, forming a crib. It was sunk to the bed of the river, sheet piles 4 inches thick were driven on the outside of the crib, then the sheathing was covered with canvas from above the water to the bed of the river and extending out from the dam on the ground some 10 feet. Sand and gravel were placed on this extension to hold the canvas in place. The excavation was made to a point about 18 feet below the surface of the water. Cofferdam No. 3 was constructed by using a crib and sheet piles as in No. 2 for an inside wall, and an outside wall of 8"x8" sawed piles driven close together and the space between the walls filled with clay and gravel. The excavation in this dam was made to a depth of about 20 feet from the surface of the water. Coffer dam No. 4 was made of two rows of sawed piles eight feet apart, forming an outer and inner wall, the piles in each row being driven close together. The space between the outer and inner walls was filled with earth and gravel. The excavation in this dam was made to a depth of about 19 feet through sand and gravel. The foundations for piers Nos. 2, 3 and 4 were constructed of two courses of 12"x12" square timber drift bolted together with ⅞ inch square iron bolts 20 inches long and overlaid with 3 inch plank firmly spiked with 8 inch spikes. The

foundations of abutments and pedestals were made of concrete, two feet in depth. The superstructure when completed will consist of four deck spans as follows: One 56 and one 68 feet supported by steel columns on stone pedestals, and two spans of 122''7¾'' c to c of end pins, and one through span of 264 feet c to c of end pins, making a total length of 639 feet of truss bridge. The deck spans are Pratt trusses. The 264 foot span is a half hitch design, the top chord being divided into three sections, as shown by the plans. The viaduct on the west side is 262 feet in length and on the east 629 feet, making the total length of 1,530 feet of steel trusses and viaduct. The masonry approach to the west end of the bridge is 162 feet and on the east 357 feet, making the total length of the bridge and approaches 2,049 feet. It has a single roadway 22 feet wide between the trusses of the channel span and two sidewalks 6 feet each in the clear, and on the deck spans, viaduct and masonry approaches the roadway is 24 feet wide and the sidewalks 7 feet each. The capacity of the channel span is for a uniform distributed load of 3,950 pounds per lineal foot, and on the deck spans and viaduct 4,350 pounds per lineal foot. The factor of safety being four on the trusses, and five on the floor system. The roadway joists are built steel I beams, having a depth of 16 to 24 inches proportioned to the length of the panel. The sidewalk joists are 10 inch rolled steel I beams. The roadway joists are riveted between, and the sidewalk joists on top of the floor beams. The grade on the west approach is 6 per cent. for 344 feet and 3.86 per cent. for 330 feet to the end of the 264 foot span. The channel span is level. The grade on the east approach is 4.4 feet in 100 feet. The floor is to be of 3 inch plank fastened to the joists the same as the Monroe street bridge.

The P. C. & St. L. R. R. and the C. C. & S. R. R. bridges will be passed as I did not have either the time or the data.

The bridges over the Muskingum river are divided as follows: Seventeen are highway and 6 are railroad, total 23. The number in each of the counties through which the river flows is as follows: Coshocton 2 railroad and 2 highway, total 4; Muskingum 3 railway and 10 highway, total 13; Morgan 2 highway; Washington 1 railway and 3 highway, total 4.

DISCUSSION.

Mr. Bowen—I would like to have Mr. Connar give in detail on the blackboard the plans of all the bridges considered; but that would consume too much time and impose upon Mr. Connar

more than he would like to submit to, probably, in one lesson. I would like to know what are the relative merits between the old wooden bridge that has served nearly sixty years, and the modern iron bridges that we are now building, taking into account their cost? If he has got that figured out in any way that he can show that the iron bridges are as much better than the wooden bridges as the cost of the one is greater than the cost of the other, I would like to hear it.

Mr. Strawn—Would you include in that, also, Mr. Bowen, the cost of maintenance?

Mr. Bowen—Oh, certainly; iron bridges have to have the floors renewed, as well as wooden ones. Of course you would not include the building of the wooden trusses.

The President—Can you give us any information on these points? That is, whether the old wooden bridges were more economical than the new iron bridges, all things taken into consideration?

Mr. Connar—I had not thought particularly about that point; but at the time these wooden bridges were built, timber was in its prime. It is very hard today to get bridge timber that will stand sixty years. There is the trouble. The iron bridge, I think, will last longer than the wooden bridge, if properly cared for. By giving it a coat of paint at the proper time, it will outlast a wooden bridge.

A Member—Mr. Chairman, I would ask the gentlemen whether there is any slipping of the floor planks on those spans that have grades? Or, is the fastaning to the joist sufficient to hold?

Mr. Connar—The fastenings are driven through, hooking in that shape (illustrating) with a tang. That is driven in the joist, and is driven in such a way that it hooks, the same as a canthook on a flange.

Mr. Bowen—If I understood your report rightly, the grade was made by fastening the girders at different elevations on the truss, the truss being made level.

Mr. Connar—Yes, sir.

Mr. Bowen—What is the reason for that? Was there any special reason for keeping the trusses level, and grading the floor in that way? Why not grade the truss?

Mr. Connar—You can do either. The only reason that can be given for making the trusses level is to avoid any crowding or slipping down on the grade, or crowding down.

Mr. Bowen—Is that a railroad bridge ?

Mr. Connar—No, it is a highway bridge. On the Fifth Street bridge, the grade is made in the truss.

Mr. Bowen—The reason I referred to it is this: I have had some experience myself in it. About twenty years ago, I designed a bridge across the Scioto river, just south of the city here. Previous to that time it was maintained, by those who had been building bridges, that it was not possible to build it any other way than to set it level on the abutments. I took the responsibility of making a different plan. The structure was 500 feet long; the two spans of 150 feet each and the balance of the 200 feet divided between the canal and railroad, and in the total distance it has a grade of nine feet. Well, that was graded in the masonry, just to suit the crown of the bridge, and was built that way, and keeps its position as well as any bridge in the county.

Mr. Connar—Is that an iron bridge ?

Mr. Bowen—Yes, sir. The State street bridge was built on the same plan. It was previously an old bridge that had been built level. The old one was taken down and a new bridge was put upon the piers and adjusted with one end four feet higher than the other. The Broad street bridge is another I planned on the same principle. That has a grade of four feet in three hundred. And since those three bridges were built, I have never observed any creeping of the iron or timbers in any way. They seemed to keep their position as well as those that are perfectly level.

Mr. Connar—I have no particular choice between the two plans.

Mr. Bowen—Understand me, I am not condemning the plan you have stated, because it is perfectly feasible to do it in that way; but it may be done in the other way.

Mr. Connar—I admit that.

A Member—Probably the shop practice has something to do with that. By making the slope in the floor and cords parallel, you get the same calculation all the way through on your parallel cords. By extending your beams down further you don't need any further calculation. That has a great deal to do with it. Theoretically I presume if you inclined your trusses that ought to be allowed for in your calculation. That is done away with in this way.

Mr. Connar—That was one of the reasons. I forgot to men-

tion it. That leaves all the posts perpendicular; the other way you have angle to contend with in making your calculations.

The President—I think in one place you said that after the piles had been driven canvas was nailed to the outside, and allowed to extend on the bed about ten feet in each direction. Was there water in the river when the canvas was put on ?

Mr. Connar—Yes, sir, eight or ten feet.

A Member—Did you have a diver to do the work ?

Mr. Connar—No, sir, sinkers were put upon it to sink it down. It is very easily done.

A Member—Is it effectual in keeping out the water ?

Mr. Connar—I think it is where you have clay on the bottom; if you have sand it is not so good.

A Member—You had several bridges where you had sand and gravel foundations, if I remember right ? You probably experienced some difficulty in keeping the water out there ?

Mr. Connar—Yes, we had a great deal of trouble in places.

A Member—Did you keep it out by pumps ?

Mr. Connar—Yes, sir, by pumps.

Mr. Strawn—Do I understand that one of those large piers was left hollow and never filled ?

Mr. Connar—Yes, sir, that was on the old Y bridge; it has stood for sixty years. They were repairing it last year and on taking the floor up from over the pier they found it hollow.

Mr. Strawn—What is the thickness of the wall ?

Mr. Connar—About two feet, and those piers I judge are about twenty-four feet high, or in that neighborhood.

Mr. Strawn—Would that be regarded to-day as a good style of work ?

Mr. Connar—I think not; I don't remember whether Mr. Dunn saw that pier when it was uncovered last spring or not.

Mr. Dunn—Yes, sir, it was about two feet or two and one-half.

A Member—How thick at the bottom ?

Mr. Connar—I don't know; I don't know what the thickness was; I think it got thicker toward the bottom.

Mr. Bowen—Do you know how that was estimated Mr. Connar ? (Laughter.)

Mr. Connar—No, I don't know anything about that.

THE JACKSONVILLE, FLORIDA, BRIDGE.

BY O. BENSON, CANTON, O.

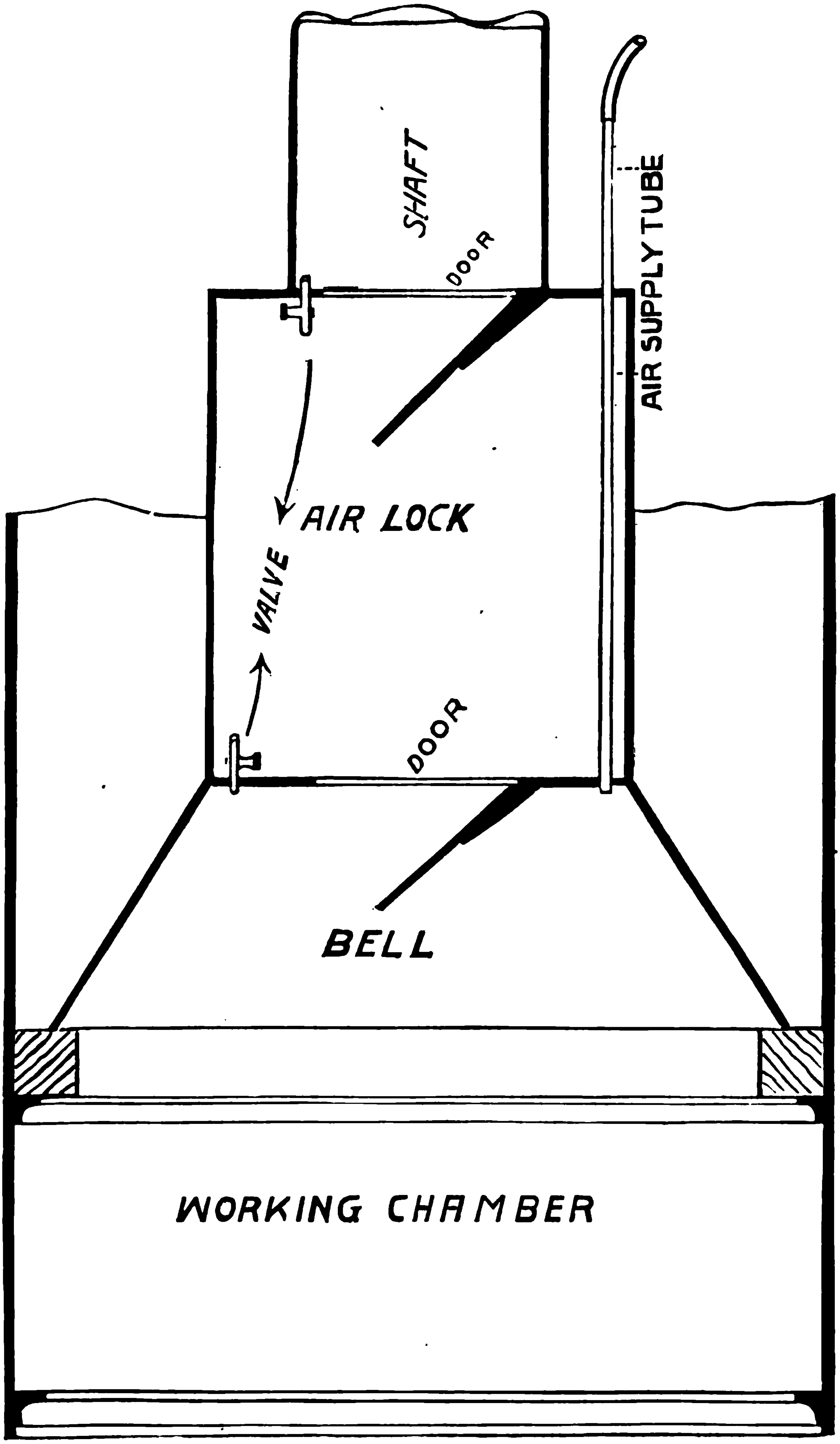
The St. Johns river, whose general course is northerly, makes an abrupt turn to the east at Jacksonville, and flows toward the ocean-tide, at this point having a maximum range of about four feet. The city, with its principal wharfs, lies along the north bank of the river, and around the angle of this bend. Across the river, opposite Jacksonville, lies the village of South Jacksonville, northern terminus of the Jacksonville, St. Augustine & Halifax River Railway. This road is owned by Mr. Flagler, of "Standard Oil" fame. The Savannah, Florida & Western Railway has a station at the west bank, near the bend, and freight cars were formerly transferred across the river on clumsy ferry boats, while passengers were compelled to transfer to a point almost one mile east of the S., F. & W. station and cross at another ferry.

It was proposed to bridge the St. Johns at a point just south of the S., F. & W. station, thus completing an all rail route from New York and the North to St. Augustine, where Mr. Flagler owns the famous winter hotels "Ponce de Leyon" and "Alcazar." Work was commenced in the winter of 1888-89, and continued without interruption until the bridge was completed in the spring of 1890, Mr. Geo. S. Morrison, being chief engineer.

This structure is a single track "through" railroad bridge, consisting of four fixed spans, each 250 feet center to center of end pins, and a draw span of 218 feet do., with 1,400 feet of creosoted pile approaches, all metal used is mild steel. Trusses were spaced 18 feet, center to center. Gauge of track is the Southern standard, 4 feet 9 inches.

Piers for fixed spans consisted of two cylinders, each 10 feet in diameter, one under each truss, which were connected by strong angle iron bracing. Soft steel five-eighths (5/8) inches thick formed the outer shell of these piers, and the interior was filled with a very excellent concrete composed of one part Portland cement, two parts sharp beach sand, and three parts sea shells called "coqvena"—the resulting compound, when set, resembles compact coral limestone. A "tumbling box" mixer was used, and the concrete rammed in the ordinary way.

In *sinking cylinders* for piers, the pneumatic process was employed. Timbers cut to the proper curve were bolted around the inside of the cylinder about five feet from the lower end, forming a ledge, and on this ledge a bell-shaped iron contrivance rested. (See sketch.)


SHAFT
DOOR
AIR SUPPLY TUBE
AIR LOCK
VALVE
DOOR
BELL
WORKING CHAMBER

An air lock, having door at top and bottom, was attached to the top of this shell. The air lock was reached by means of an iron shaft three (3) feet in diameter, bolted up in sections, and having a ladder attached to the inside. All joints were made tight by means of oakum and lead calking. Bags of sand were thrown in, and water admitted above the bell to weight the cylinder down. That part of the cylinder below the bell, which was, of course, the working chamber, was supplied with air through a hose connected with a compressor.

The material encountered in sinking piers was a soft coral limestone of very irregular formation, which could not be successfully blasted, while it was so hard that a shovel would not penetrate it. It was therefore necessary to loosen this material in small fragments with a pick. Material excavated was shoveled into sacks and lifted to the air lock above, from which it was hoisted with block and tackle.

After material had been removed to a depth of one or two feet below the lower end of the cylinder, the men were called out, air shut off at the compressor, and a valve was opened, which allowed air to escape from the working chamber and relieve the cylinder of its buoyant effort. This usually caused the cylinder to go down with a rush. Loose material was also scoured away from under the cutting edge by water, which came in to take the place of escaping air. Air pressure was then turned on, and when it had forced the water from the chamber, men were again sent down.

This work was very tedious, it being often impossible to sink more than six inches per day. Logs were sometimes found imbedded in the rock, also pockets and veins filled with sand, or pure spring water.

After a cylinder had been sunk to the desired depth upon a good foundation, the working chamber was filled with concrete, passed down through the air lock in sacks, and after this had set, water was pumped out from above, so that the shaft, air lock, etc., could be removed. The remainder of the cylinder was then filled with concrete.

One cylinder near the west shore, which penetrated the rock but a short distance, was suddenly buoyed up a distance of about three feet while being pumped out in this way, to the great consternation of superstitious negroes employed. This made it necessary to remove the concrete already in place and again sink the cylinder—an operation involving cost greater than that of the original.


JACKSONVILLE BRIDGE OCT 23RD 1889 LOCATION OF SPAN "A" 1.24 P.M.

ERECTION OF SPANS.

The draw span was erected on the crib work which had een constructed for its protection, but fixed spans were erected ne at a time, on two barges which were moored about one and ne-half miles from the bridge site.

Each barge was simply a strong wooden box 114½ feet long nd 30½ feet wide. After erecting a span, it was towed to lace at high water and lowered on its seat by the receding tide, ided by the removal of plugs from holes in the bottom of arges. These barges were then towed away and another span vas erected on the same blocking. This method saved very xpensive false work, which would otherwise have been reuired, as the river is very deep, and the bottom, some of which s bare rock, is often swept by swift currents.

TIMBER.

All timber used in any part of this structure, except crib vork, was creosoted, long-leaf Florida Pine. Unprotected mber decays very rapidly in that warm, moist climate, while ne life of an ordinary pile driven in water is about four ears, as it is quickly eaten off between high and low water y shell fish and marine insects, aided by the saline water itself.

The company that supplied the creosoted piles for this work laims that they will last twenty years.

MPROVEMENT OF COUNTRY ROADS.—THEIR NECESSITY.

BY G. S. INNIS, COLUMBUS, O.

On this branch of the subject little need be said, after taking ride over them, especially near our large cities. In certain mes of the year, for instance when the ground has recently nawed out, or after heavy rains, they become almost, or quite, npassable for ordinary loads. A farm ten miles from market, nd nothing better than mud roads for its owner to pass over to ell his produce, is not worth more than half as much as it would e with a good improved road.

THE SURVEY.

In locating a permanent road care must be taken that the

survey is exactly on the line it purports to be, when this line is supposed to divide farms, sections or other sub-divisions of land. If this is well done it is worth money to the land holders and tax payers ever afterward. If not well done it causes expense and other trouble for all time to come.

CULVERTS AND BRIDGES.

One of these should be made at every water course naturally crossing the proposed road. It does not pay to turn even a small stream of water down the gutter or side ditch to save the expense of a culvert. It will both wash the side of the road and keep it wet longer than is necessary, and thus cost more for repairs than the cost of the culvert would have been when making the road.

These culverts must be made of good material, if it is desired to make the best use of the people's money taxed to build the road. If the road is a thoroughfare or one much traveled, the culverts should be twenty-four feet long from outside to outside. With less important roads twenty feet will be found sufficient. In all cases they must be made abundantly large to carry off the water of the streams passing through them. The side walls must be made two feet thick and be well put down so as to be below any danger from frost, and the top of the arch or covering at least eighteen inches below the finished surface of the roadway.

GRADING.

This should be well done, and in no place as steep as the limit allowed by law. As for width, twenty-six feet will be found sufficient for most country roads. It should have a crown in the centre of eight inches at least, and for the widest roads twelve inches will not be found too much. The mistake commonly made in grading roads is making them too high. Roads and their side ditches or gutters should, of the two, drain the water from the adjoining lands, and not on to those lands. The owners of these adjoining lands pay for the improvement and they have an equitable right to every benefit which can reasonably be made for them.

DRAINAGE.

For this purpose, make good ditches along each side of the road, at least from twelve to fifteen inches deep. Then, in every natural water course, ditches must be cut through the adjoining lands deep enough to drain the side ditches along the road to the bot-

tom, and in no case left so that pools of water will stand in these side ditches. Remember that a good road cannot be made at reasonable expense unless well drained.

GRAVELING THE ROAD BED.

Here comes the rub. What material shall be used? The most of our bank or river gravel is too soft for the best results. When wet it cuts into ruts badly, if indeed it does not become mud. If bank gravel is used care must be taken in selecting it. In no case use gravel mixed with slate or red sandstone. That of uniform gray color is the best we have in the white limestone region. Crushed blue limestone, when solid, at fifty per cent. advance in price, is cheaper in the end than most of our bank gravels. Care must be taken to have it crushed fine enough so it will cement into a hard smooth surface. No large pieces or slabs must be put in the bottom, unless indeed, they are put so low as to require as much fine broken material over them as at other places. Then they only fill up and are no better than clay, except in boggy or swampy land.

The usual rule is to accept no piece of broken stone too large to go every way through a ring one and three-fourths inches in diameter. This rule must be rigidly enforced if we expect a good smooth surfaced road, and unless we make a good road why incur the expense of the improvement? The same is true of gravel. If too coarse, the road will always be rough. Still fine sand should be rejected, and in no case the least loam or clay should be mixed with the gravel.

As to depth, it must not be less than twelve inches in the centre, and eight inches at each edge. Twelve feet wide for most roads will be found sufficient, but where much travel is expected, this width should be increased from two to four feet. Whether broken stone or gravel is used, care must be taken in spreading it, to work the coarser material to the bottom, and so spread as to have a smooth and regular crowning surface. Remember that the smoother surface your road has, the better it answers the purpose for which you spend your own, as well as your neighbor's money.

If the best results are expected these improved roads must be kept in good repair. It is worse than folly to allow them to be cut into holes and ruts, before anything is done towards repairing them. It is a waste of money. Nothing repairs a road so cheaply as a good scraper. Scrape often until your road bed becomes solid, and after that it will require less attention.

TURNPIKE SPECIFICATIONS FOR NEWTONSVILLE AND BOSTON FREE TURNPIKE, CLERMONT COUNTY, OHIO.

BY GEO. H. HILL, MILFORD, O.

For about twelve years past the commissioners of Clermont county, Ohio, have been building from twelve to fifteen miles of free turnpikes each year. Said turnpikes in said county are all built under special acts of the legislature of the State of Ohio, requiring the people along the line of said roads to pay twenty per cent. of the cost of construction. The commissioners, under these acts, determine how many miles of road they will build in a certain vicinity each year, distributing them over different parts of the county, and levy the tax for the remaining 80 per cent. of the cost. They select their own engineers, sometimes having two or three engineers at the same time, assigning them so as to give the engineer work nearest his home. The roads are surveyed by the engineer under the direction of the commissioners, acting as viewers. The commissioners also dictate the kind of road they will build, with width and depth of metal, and leave the rest of the work to the engineer, including profile, specifications, estimates of cost, etc. They are then advertised for sale in two of the county papers, and sold at public outcry, by the county auditor, to the lowest responsible bidder, in the presence of the commissioners and engineer, who reads the specifications, along the line of the roads, in half mile sections. The contractor is then required to give a bond and signs a contract to complete the road in accordance with the specifications. When the work is to commence, the commissioners assign to one of their number a certain number of the roads, to oversee the construction of the same, in connection with the engineer on that road, and when a road or section is to be received, they generally all meet together with the engineer, to examine the same, and then require the engineer to make a report in writing as to its accordance with the specifications. I had charge of about three-fourths of these roads as engineer, from 1884 to January 1, 1892, the other engineers using my general specifications. The specifications which follow are the outgrowth of what seemed to me to be needed for the construction of said roads under the joint supervision of the engineer and one of the commissions. I herewith also furnish a copy of my work for Section I of the road, as read on the day of sale.

Said turnpike is to be built on the line of the road as laid out by the engineer under the direction of the commissioners of Clermont county, Ohio, and as shown by the plat and description of route also shown by the stakes along the center line of said road.

The contractor must clear the road of all obstructions to the width of 36 feet, unless otherwise directed by the commissioners. All trees and stumps within the area required for the road bed and ditches must be grubbed and removed therefrom, except in fills, where they may be cut off level with the ground and covered over. All rubbish and other material liable to obstruct the water way between the abutments of any bridge built by the commissioners or contractor must be removed to a depth sufficient for the necessary waterway.

Contractors must preserve all monuments set for corners to lands, which may be found within the limits of said road.

Said turnpike is to be graded 24 feet wide on top of all fills (or 12 feet from the center line of the road) and made 26 feet wide at the base of all cuts or (13 feet from the center line) and made with a crown of eight inches above the edges, counting 10 feet on each side of center line to edges, and 26 feet between the ditches, except where the specified slope of sides might require more than 26 feet, then the width to be increased as may be needed. The slope of banks in cuttings is to be one horizontal to one perpendicular, and that of fills to be one and one-half horizontal to one perpendicular, and in all cases both of cuts and fills, the sides to be made a regular slope from the top to the bottom. The edges are to be made straight and the surface of uniform appearance, without holes and bumps, upon said road bed, the entire width for the metal area and in making the fills the dirt must first be taken from the high places to fill the low places as far as practicable, provided the distance may not exceed 600 feet. The surface height of the road is that which is referred to by the top of stake in the center line of the road before the cuts and fills are made, and the grade height is that to which the road bed is to be completed by making the cuts and fills in accordance with the engineer's profile and description of cuts and fills, as shown by the grade line on said profile, above or below the corresponding surface height, exclusive of the metal. The figures showing cuts and fills, marked on side stakes and in description of cuts and fills, are given in feet and tenths of a foot, and they refer to the top of the stakes in the center line of the road, also to the crown

of the road bed when completed (*exclusive* of the metal,) that is to say, if marked 2.5 feet, it is to be cut down 2.5 feet from the top of stakes at that point in the center line, and the sides enough lower to give the required crown, and when fills are marked two or more feet high, an increase of 10 per cent. in height above that which is marked may be required to allow for settling. The grading is also to be made regular and straight from point to point as shown by the grade line on profile, from one crossed (x) stake or number to another, as shown also in the left margin of description of cuts and fills, unless otherwise shown on profile and where bridges intervene. Also straight on top from center line to sides. (See cross section profile.) The stakes with a cross (x) on them, or the crossed numbers in the left margin of description of cuts and fills, are the *governing* ones; the others are intended to be approximately correct, but may vary a little above or below. Any errors that may have been made in marking the side stakes, and which do not correspond with the profile and description, are to be corrected by the engineer without incurring any extra compensation or reduction. The grading is to be examined and approved by the engineer before the stone and gravel is hauled upon the road bed to prevent it, and to enable this to be done not less than one-half of a section is to be completed for examination at a time. The grading must all be completed on or before July 15, 1891, and, should the road bed be cut up by travel or otherwise, after being approved, the contractor must fill up and smooth off the uneven places in the road bed, at least 100 feet at a time, ahead of the stone being put on the road.

The word *culvert* in these specifications will be understood to mean the masonry for water ways across the road, and covered with stone caps, and the word *bridge* to mean masonry covered with wood tops. All culverts and bridges required to be made by the contractor are to be completed, with the grading before the metal is to be put on, on or before July 15, 1891, and are to be built at all points shown on profile or in description of cuts and fills of the size and dimensions therein named.

Common culverts are marked 1'x1'x24' or '2x2'x24', etc., and the meaning is one foot square or two feet square in the opening and twenty-four feet long. They are to have walls not less than two feet thick, and to be paved in the bottom with stones set on edge perpendicularly (not inclined) and made one foot deep, fastened and well protected at the ends to prevent undermining. The walls are to go down to a depth of two feet below the top of pavement, or lower if necessary, to secure a

good foundation. They are to be strengthened at the ends by wings not less than two feet in the rear of the walls, to go down to the same depth as the walls, and carried up as high as the top of the cap stones, united to the walls by joints well broken, and set parallel with the center line of the road, the ends built up square, and the top course of stone to be long enough to reach across the two feet of wall. The top of pavement is to be set with enough inclination to give good drainage. The walls must be built of good stone, laid up dry, close enough to give stability and well bound together. The top is to be covered with two layers of good sound stone, not less than three inches thick, so laid as to break joints thoroughly, both layers to be laid close, and the under layer to be made of stone long enough to extend not less than fifteen inches beyond the face of the walls. No culvert is to be less than twenty-four feet long, and when made under a fill a wall must be built over the ends long enough to extend to the end of each wing, and high enough to hold said fill, the thickness of the walls to be regulated by their height, as in other cases hereinafter mentioned, but in no case less than two feet thick; and the top course to be made of stone large enough to reach across the width of the walls. Also in cases where the fill over a culvert may exceed three feet in height, then the culvert must be increased in length three feet for every additional foot in height, with wall over the ends as before named, said increase in length to govern, whether so marked or not.

Small bridges are to have walls twenty feet long on top, and battered from base upward about one inch to the foot, with wing walls similar to culverts, except that the wings must be carried up to the height of the top of the floor boards, as a parapet, to hold the banking, which in this place must be made of finely broken stone and gravel the entire space between the wings, and three feet wide outward from the floor boards on each side, and carried up so that it will be flush with the top of floor boards the whole length of the floor after settling, and gradually slope back to the same level as the rest of the banking. If said bridges are four feet, or less, between the walls, they are to be paved on the bottom the same as culverts. The thickness of the walls or abutments of bridges at the base will be governed by their height, and, as a general rule, will be required equal to one-half their height, counting from foundation to top, unless otherwise expressed. In all cases the walls or abutments for bridges must be carried up high enough to correspond with the top of the grade or fills, connected therewith, as shown by the profile, whether so marked or not, and also to go down deep

enough to secure a good solid foundation without any extras in either case. Also if walls are needed to connect with the ends of wings to hold the fills, the contractor must build them at his own expense, provided they shall not exceed fifteen feet in length. The covering of bridges is to be made with cross ties or joists, *eight* in number, as follows:—If 4 feet or less between the walls, or abutments, they are to be 6x4 inches; if 5 to 6 feet between the walls, they are to be 8x4 inches; if 7 to 8 feet between the walls, they are to be 10x4 inches; if 9 to 10 feet between the walls, they are to be 12x4 inches; if 11 to 12 feet between the walls they are to be 14x4 inches, and long enough to extend 15 inches beyond the face of the walls, the ends resting on a board one foot wide and two and one-half inches thick, and eighteen feet long, laid on top of the wall, and the edge laid three inches back from the face of the walls. The ends of the joists are to be capped with a board wide enough to rest on the wall and extend to the top of the floor, spiked to the ends of the joists, the bottom board and the floor. The top or floor is to be made of boards about eight inches wide, two and one-half inches thick and eighteen feet long, except when made on a skew, then the length is to be increased enough to make it measure eighteen feet square across. The floor must be thoroughly spiked to the joists, with good large spikes in each joist, and then completed with a good board 2x6 inches wide, spiked down over the ends to keep the boards in place; also, if eight feet or more between the walls, they are to have good side railing put on for protection.

All lumber for said bridges must be of white oak and of the best quality, and also all stone for masonry to be of good quality and laid up dry unless otherwise expressed. Stone to be of sufficient size to give stability, well bound together, joints properly broken and laid in a workmanlike manner. The contractor to furnish all materials, and build all culverts and bridges called for, unless otherwise mentioned, and to have them all completed within the time previously mentioned. Masonry for large bridges as per special specifications.

The metal part of the road bed is to be built as follows: 1st. A foundation of coarsely broken stone ten feet wide (five feet on each side of the center line of the road) and seven inches deep, pieces not to exceed four inches in longest dimensions.

2nd. A layer of napping or finely broken stone, on top of the said foundations ten feet wide and three inches deep, pieces not to exceed two inches in longest dimensions, and so spread as to give the required grade and crown, even if it take more than

ten inches in depth to make it so, where the grade has not been properly prepared.

3rd. A layer of finely pulverized dirt, to be put on *with a shovel* (and not with a scraper) just enough to fill up the depressions in the surface between the broken stone.

4th. A layer of good gravel (the best that can be obtained in the vicinity of the road at a reasonable distance) ten feet wide and two inches deep, spread and raked evenly, so as not to leave holes to contain water, and if mixed with rock, the large pieces must be broken up, so as to mix with the gravel and form a smooth surface on top, corresponding with the required grade underneath, and if not so made, the commissioners may require enough more metal put on top to make it so. Said foundation and napping are to be put on between two boards ten inches wide and filled up to the top of the boards on the sides and to the top of a stake set in the center, high enough to give the required crown and not less than ten inches above ground. Boards enough must be laid and used at a time to make not less than fifty feet in length and set full ten feet apart in the clear, and in line on top corresponding with the inclination of the road as required, and at the same level on each side, so that when completed the road will not be higher on one side than the other, also to be set parallel with the center line of the road, except where there are short angles in the road line, in which case they should be set so as to make a nice curve, also, before the said boards are removed. banking enough must be placed on the sides to hold the stone in place, and made as high as the top of the boards. If the engineer or commissioner in charge have reason to believe there is not enough stone being put on, they may require that the dirt and gravel shall not be put on till it is examined and approved, and in no case is dirt to be used as a substitute for the required amount of stone and gravel. After the metal is put on, the banking is to be completed without delay to prevent the metal from spreading.

The banking must be made on the same slope as the required road crown to a distance of four feet on each side of the metal, up to the same height as the metal, but not above it, making the road full eighteen feet wide on top when completed, and the slope by regular grade to the center of the side ditches, or to the base of fills. (See cross section profile.) Said banking must also be dressed up evenly, so as to give good side drainage and not be left with holes and bumps and ragged edges, but in straight lines, parallel with the center line of the road.

The side drains, or ditches, must be made even and

straight corresponding to the line of the road, also corresponding to the grade of the road in the bottom, as near as possible, and cleaned out so as to allow the water to flow through them to the culverts or outlets. The contractor must also open ditches for the outlets of water from the ends of culverts and bridges so as to allow the water to leave the road, provided said ditch may not be required to a greater distance than fifty feet from said culvert or bridge.

The contractor must also build catch waters or water breaks on the hill slopes at intervals of 100 feet, where the slopes are three degrees or less, and at intervals of about fifty feet, where the slopes exceed three degrees. Said catch waters are to be made of finely broken stone, put on top of the regular surface, and laid in the shape of the letter V, with the angle up the hill, and then covered with gravel the same as the rest of the road. They must be made long enough to extend beyond the metal area of the road to the edge of the embankments, or to the side drains. They must be made high enough to turn the water off the metal area of the road, and wide enough to give an easy grade over them.

Said turnpike is laid out forty feet wide, except where a greater width is needed in making the required slope in cuts and fills, and in procuring dirt for banking and fills, in which case the width may be increased to any width needed, not exceeding sixty feet, which increase in width is to be a part of the right of way along said road, the side stakes now set twenty feet from the center line, not being set for the limit of boundary in such places.

All earth, timber, stone, gravel, or other material, naturally belonging within the limits of width of road as fixed by the county commissioners may be used by the contractor in the construction of said road, unless reserved on the day of sale, by the commissioners. All other materials needed in the construction of said road must be furnished by the contractor at his own expense, but in case the contractor shall be unable to agree with the owners of stone, gravel, etc., for the purchase of the same, at reasonable cost, together with the right of way to the same, then the commissioners will procure the same at such point as they may select, provided it does not interfere with the contract previously made with some other contractor on the same road. And if said commissioners are unable to agree with the owners thereof at reasonable rates, they will proceed either by arbitration, or according to the law provided in such cases, at their own expense to condemn the same, but the contractor will be charged

for the cost of said material to be reserved out of the said contractor's bid, on final settlement. Also if owners of material as aforesaid have reason to believe that they will not be paid by said contractor for said material, the said county commissioners will guarantee the payment of the same upon the presentation of a certificate from said contractor, that said material has been received, together with the price agreed upon, and will reserve the same out of the contractor's bid, provided said certificate be presented before said contractor's work shall have been received and the work paid for.

Before commencing the work of grading, the contractor must furnish good solid stakes for grade stakes, and assist the engineer in setting them at his own expense, as a part of the preliminary work of the construction of said road, and when once set, must keep them in place as far as possible, together with the side stakes, till the road is completed, both for his own benefit and for the convenience of the engineer, in making out estimates and keeping the line of the road.

The commissioners, auditor and engineer will not recognize any sub-contractor in connection with these specifications, or keep the accounts with them, but hold the original contractor and his bondsmen responsible for all the work to be done. He must collect his own estimates, or give orders for the same, keep all his own accounts with his sub-contractors and laborers, and be responsible for all their acts and work.

As the work progesses the enginner shall take account of the work done in contiguous portions, amounting to $50.00 or upwards, semi-monthly, and issue his certificate for the same to the commissioners, less 25 per cent. on each estimate, reserving also enough to pay for the material, whereupon the said commissioners may pass upon the same and order it paid upon the order of the county auditor, provided that if the work is not being done in a manner satisfactory to the engineer or commissioner in charge, said certificate may be withheld till made satisfactory. Said contractor is also herein required to do and perform all the work required in these specifications as prescribed therein, in a good and workmanlike manner, and to comply with the orders of the engineer and commissioners made in accordance therewith.

The commissioners and engineer reserve the right to make any changes in the line of the road, or grade, or otherwise, as may be found necessary in the construction of the same, and if *more* work is required by the change, the contractor is to receive extra pay for the same, to be estimated by the engineer,

and if *less* work is required, then there is to be a corresponding reduction, to be estimated as above by the engineer, but the contractor is not to make any changes on his own account without permission of the engineer or commissioner in charge of the road, and shall be held liable to have the work rejected or discounted for any such changes that will lessen the cost of construction to the full extent of such changes or omissions.

Said work may be commenced between the first day of April and the first day of May A. D., 1891, and must be completed on or before the 15th day of October, 1891. If the contractor fails to complete the section, or sections, contracted for within the time herein specified, said commissioners may withhold any further estimates or payments thereon till the work is completed, and said commissioners will also hold the contractor and his bondsmen responsible for the repair of any or all damages that may result by reason of travel, washes or slides that may occur during the interval of such delay, and also for any other damages that may result on account of such failure, unless excused by the commissioners for good cause, of which the said commissioners shall be the sole judges, and in addition to the above, they may declare the contract forfeited, without recourse on them.

Bids will be received on day of sale for the performance of the foregoing work of building said turnpike by half mile sections, a fraction of a section as shown in description of profile of cuts and fills. The lowest responsible bidder to be the purchaser, and the said purchaser to enter into bond satisfactory to the commissioners of Clermont County, Ohio, and sign a contract for the faithful performance of all the work above described in accordance with these specifications which together with profile and description of cuts and fills is hereby made a part of the said contract. Said commissioners may alsc require bidders to name some responsible person, satisfactory to them, who will go on the bond with them in case of award, before their bids will be received. They also reserve the right to reject any or all bids. A copy of these specifications, together with description of cuts and fills, is to be furnished by the engineer, for the contractor and commissioners before the work begins, and in case of any omissions or errors in the copy furnished by the contractor, the original specifications read on day of sale are to be binding in such cases, and the engineer shall have the right to correct the same to correspond with the original.

December 9, 1890. GEO. H. HILL, Engineer.

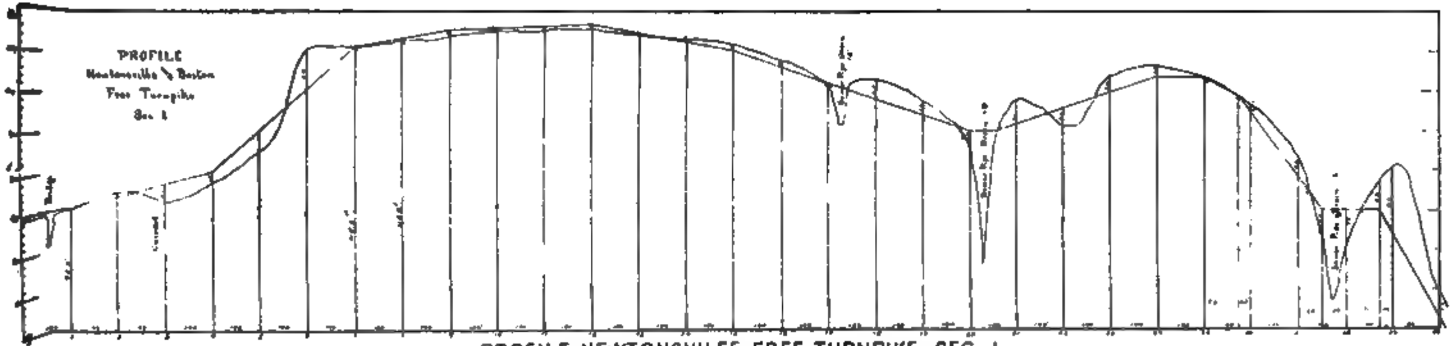
ESTIMATED COST OF SECTION I.

Grading—Cuts, 1,716 cu. yd.; fills, 1,483 cu. yd.	$ 218 00
Bridge and Culverts, 97X28X20X65	210 00
Stone and Gravel in creeks { $\frac{1}{8}$ $\frac{30}{88}$ } perch per rod, for 160 rods .	102 00
Hauling stone 2½ miles for 160 rods @ 3.30 per rod . . .	528 00
Hauling gravel one mile for 160 rods @ .30¼ per rod	53 00
Breaking stone for 160 rods @ .70 per rod	112 00
Banking sides for 160 rods @ 20 per rod	32 00
Putting dirt on stone for 160 rods @ .10 per rod	16 00
Total estimated cost, ...	$1,271 00
Sold for, ...	995 00
Sale, less than estimate, ...	$ 276 00

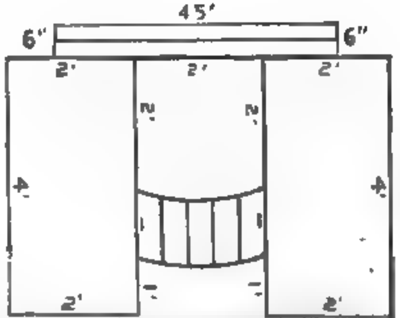
REMARKS ON THE DIFFICULTIES ENCOUNTERED IN THE CONSTRUCTION OF THE WORK, ETC.

My experience is, that the majority of contractors need watching closely to get the work done according to the specifications. In regard to the grade, the tendency is to make the sides in cuts and fills too steep and not make the fills high enough or wide enough. I have had my grade stakes changed after setting them, and then had them contend with me that they were just as I had set them. I generally guard these points by setting secret marks, or checks out of the way, where they will not be disturbed by the contractors. In regard to the metal, the tendency is to set the boards so as to make the width less than called for, to lessen the depth from one to two inches or more; and to leave the pieces too large, and sometimes lay them flat, without breaking at all.

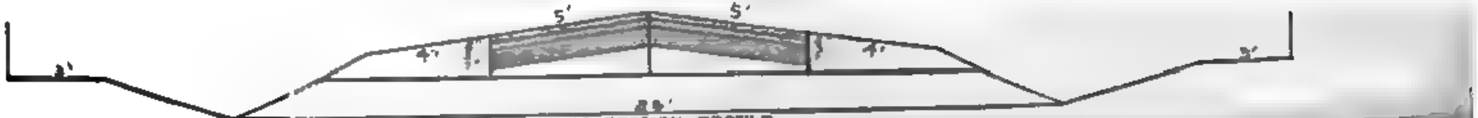
In regard to culverts and bridges, the tendency is to build the walls on top of the ground, and not go down to the depth called for. These points have to be watched very closely. But the hardest thing to accomplish is to get the work all completed within the time specified. This sometimes causes very great inconvenience to the people who have to travel the road, and is a source of great annoyance to the engineer and commissioners as they are the persons whom the people blame. Under my supervision this delay has sometimes been caused by the difficulty encountered by the contractor in procuring material, and a right of way to get to it. When the people are petitioning to the commissioners to have the turnpike built, they will be told that material is plenty and easy of access, but after the road is sold out, the owners of material sometimes conclude they want it for their own use, or want so high a price for it, that the contractor can not afford to pay it, or they are not willing to grant a right of



PROFILE NEWTONSVILEE FREE TURNPIKE, SEC. I,



CROSS SECT ON COMMON CULVERT



CROSS SECTION PROFILE

way to the material. Then the contractor is forced to have the metal condemned, or go further for it, which leads to delays. I think the law in reference to this matter was modified last winter, but is still defective, if I understand its provisions, in not providing for condemning a way to get to the material. I wish to say before closing that I am not in favor of having one of the commissioners, (or all of them) to act in conjunction with the engineer to superintend the construction of these roads, and I think it would be well to have the law so made as to give the engineer the sole supervision of this part of the work. It would lessen the expense to the county nearly one-half, and there would then be no conflict between the directions of the engineer and commissioners as has sometimes occurred in my experience. Again, in my opinion, the repair of these roads, together with reconstruction of all bridges, should be placed under the superintendence of a competent engineer, instead of the township trustees and county commissioners, as is now done, under the existing laws of Ohio. The reason is perhaps not one in ten of these officers have any knowledge of road engineering or bridge work. Indeed the work done in many instances shows the above remark to be true. Yet they have the letting and passing upon nearly all of these structures, without the assistance of an engineer, except in the very large structures. Why not put the letting, overseeing and taking up of all this work in the hands of a competent engineer, giving him as much territory by townships or otherwise as he could well manage, he making his report of the samé to the trustees or commissioners. I think also his appointment should be made by the court, and non-partisan, if possible, so there would be no inducement to show political favors in giving out contracts, or accepting work done, as I have reason to believe is often done, under existing laws. I drop these remarks that our committee on legislation may have something to think about.

REPORT OF THE COMMITTEE ON HIGHWAYS.

Mr. President:

In the preparation of this report I have not taken the time with this instrument that I should. I put it off until near the time of the meeting and then I find myself so pressed with work that I cannot present you with such matter as this subject deserves.

I have written to all the members of the committee asking

their co-operation in this matter. But one has come to my relief, Bro. E. B. Opdycke, of Pulaski, who has furnished us with some excellent thoughts. He says that "In the wet and murky " sections of our country in this season the people are again re-" minded of the necessity of good roads. The wheel scrapers, as " ordinarily used, are an unmitigated nuisance, scraping the sods " and soil up into the form of a hogsback or narrow ridge and " one can drive with comfort, neither on the ridge nor along the " sides."

" I have seen broken stone which were shipped in at consid-" erable expense, industriously and carefully placed on a leading " thoroughfare of an adjoining county, which after a thorough " trial, proved a failure and the work was regraded and grav-" eled."

" So far as I have observed, if there can be had good gravel, " there is no better material for the common county highway."

One primary thing to do is to thoroughly drain the road bed to some outlet.

It is all well enough to talk of the great value of road improvement, the increased value given to land, but the progress therein should be controlled by the taxpayers' ability to pay.

The macadamizing of roads is a fine thing, but a headlong plunge into it may swamp the taxpayer, and I am not one who is in favor of constantly incurring a heavy indebtedness even for the prosecution of public improvements. Who would have the impudence and lack of common sense to urge upon a pioneer in a new country to build a fine palace on his new premises instead of the log house with puncheon floor, until he had gathered sufficient impetus to erect the finer structure.

Is not the jostling and jarring and good shaking up of the stumpy and corduroy road a necessity of the primitive dweller? Is not the road today quite in keeping with the land owner's ability to pay? E. B. OPDYCKE.

As to the needs of good roads and the reasons for their improvements pro and con, I have nothing to add to what has been said many times, but I will confine myself to what we have done in the direction of road improvement the last year in Crawford county.

During the session of the legislature of this State of 1890-91 a law was enacted providing for the improvement of highways in corner township of counties, having within said township cities of the fourth grade of the second class.

The substance of that law is as follows: Trustees shall, on petition of one hundred or more taxpayers, including said city,

submit the improvement to a vote of the qualified electors of said township within sixty days.

At such election, if a majority of the votes are found in favor of the improvement, a commission shall be appointed by said trustees, to consist of three freeholders of said township, whose duty it shall be to return a plat of said township with the roads designated thereon that shall be improved. No road shall be designated that does not extend beyond the lines of said township. The commission shall employ an engineer for the work and profiles of all roads so designated shall be made and returned to the trustees.

After the commission has made its report the trustees shall proceed to improve such portions of such roads designated as in their judgment the case demands first.

The trustees shall employ a competent engineer who shall be known as superintendent of improved roads.

No road shall be improved having a less width than forty feet.

The improvement on the road bed shall not be less than ten, nor more than sixteen feet wide. All such improvements shall be free turnpikes.

The whole work shall be paid for by a general tax against all properties shown upon the duplicate. The levy shall each year not exceed three mills, and such levy shall continue from year to year until all roads designated shall be improved. There shall be at no time bonds to exceed $50,000 standing out. They shall provide a fund for repairs.

Under the provisions of this act the trustees of Polk township, Crawford county, Ohio, in which the city of Galion is situated, after conforming to its provisions, proceeded to improve about seven miles of its roads, portions leading each way from the city, as follows: 1st. Your humble servant was appointed superintendent and plans and specifications were prepared and the work let, by sealed bids, to the lowest bidders. The plans and specifications provided for the grading of a road bed, generally twenty-six feet wide on its finished surface, eight inches crown in cuts and level on fills. Slopes in cuts 1½ to 1, on fills 2 to 1. Ditches not less than 18′ deep with outside banks sloping not less than 1½ to 1. The proper drainage was amply provided for.

After the grade was satisfactory the stoning was commenced.

1st. A layer of sandstone, found in the local quarries, nine feet wide, 5″ thick in the center, and 4″ at the side, was placed upon the grade on the right side going toward the city, the center line of the grade being the inner side of the sandstone. This

stone was composed of pieces of various sizes, some broad and flat, which was laid along the center with the spaces between well filled and hammered solid and others of cubs of about 4″. A solid mass was obtained by laying and breaking and hammering to the required thickness.

When the sandstone foundation was properly prepared and ready, crushed limestone was then added, which was eleven feet wide, extending one foot on each side of the sandstone. This was to be of such thickness that when the whole mass was solidly compacted it should measure twelve inches in the center and seven inches at the sides. Over all a layer of gravel was spread 1½ inches thick in center and one inch at sides. (The gravel was omitted.)

By using the sandstone foundation the work was bettered and cheapened.

By placing the stoning on the right side going to the city more loaded teams would have the right of way on the turn out and a dirt road for summer use was provided and the pike thereby relieved of much wear and tear.

The contractors were "old" at the business and gave me quite a training. They wanted a great deal that I didn't, and my wants did not suit them always. Grade stakes they had no use for. But a provision in the specification making them pay for resetting them, had a wholesome influence in keeping them in place.

When the work was ready for the crushed limestone I asked the contractors to place an additional thickness on the road of 1½ inches in the center and one inch at the sides to allow for settling. This would make the work measure 13½″ in the center and 8″ at the sides.

They objected to that amount, claiming that it would not shrink or settle that much. I placed an inspector on the work, who carried out the instructions for that amount. The inspector received $2 per day and in return the amount of stone above specified was placed upon the road which was equal to $15 per day in value.

The contractors would disobey and put on more sandstone than required, after which I required the full amount of limestone over and above the sandstone.

A case of arbitration grew out of this and the work was measured and examined, after which the question to decide was "how much would it settle?" I searched all my books and found scarcely anything on the subject. I got the opinions of a number of engineers, but they differed. I did the best I could and

presented what I had and the arbitrators brought in a report against the contractors and in favor of the township.

I would like very much to have the opinion of this body on this question of the shrinkage of crushed limestone after being placed upon our roads and streets.

Now, as the matter of expense is one of the first things to be examined and considered in all public improvements, and especially in the piking of our public highways, I think it not amiss in this report to embody a general statement of the costs of our improved roads.

The grading cost from 10 to 15 cents per cu. yd.
Sandstone 90 cents to $1.00 per cu. yd. in place on the road.

Limestone cost f. o. b. cars at Galion (hauled from Marion)	$1.15 per cu. yd.
Loading on wagons,	.10 per cu. yd.
Hauling, average two miles,	.40 per cu. yd.
Spreading,	. 5 per cu. yd.
Total,	$1.70 per cu. yd.

Thirteen cu. yds. of sandstone laid 100 lineal feet of road.
Twenty-five cu. yds. of limestone laid 100 lineal feet of road.
Stoning one mile of road, $3,036.
One cu. yd. of crushed limestone weighed 2,650 pounds.

Afterward a short piece of road was built, substituting native gravel (not limestone gravel) for the crushed limestone.

The covering of sandstone was 11 feet wide, 6" in the center and 3 inches at the side. The gravel was 13 feet wide, and the whole mass measured 16" in the center and 8 inches at the side. This was placed in the center of the road bed, and cost, complete, about $2,200 per mile, grading and all. From the present indications this gravel road, with its sandstone foundation, will be the road of the future here, except on roads subject to heavy traffic.

The whole work done is meeting the approval of the taxpayers, and the manner of payment brings it within reach of all without distress, and our city feels that bad roads will no longer turn trade into other channels and result in depressing our business and our people. Resp't. submitted,

J. B. WEDDELL, Chairman.

DISCUSSION.

Mr. Innis—As to shrinking of crushed limestone, I speak now of blue limestone, I had a little experience about a year ago. I was called on to view or pass upon the manner of construction of a turnpike in Union county. It commenced at the Franklin county line and ran two or three miles up into another free turnpike. To enable myself to judge how much the

shrinkage ought to be, I took a free turnpike in Franklin county and constructed under the superintendence of Mr. Davis, an engineer at Dublin, Ohio. I measured a number of places. The crushed stone had been put on twelve inches thick originally. I drove down an iron bar and got to the bottom of the crushed stone and measured a number of places, as many as ten or twelve. That was about a mile in length. It ran sometimes 10½ and sometimes 11 inches. No place more than 11 and I think no place less than 10½ inches, so that I concluded it settled about an inch or an inch and a quarter in twelve, a shrinkage of about one-twelfth or a little more.

The President—There have been two questions handed in; the first is: "In laying out one mile free turnpikes, the statutes make it the duty of the engineer to lay down the boundary lines for the assessments to construct the road. Where the line of the road is crooked, is there any established rule for locating the boundary at the ends of the road.

[Signed,] W. S. Fox."

Can any gentlemen present make an answer to the question?

Mr. Innis—I have always taken it at right angles to the last bearing of the road at each end.

A Member—I believe there are quite a number of one mile roads in Marion county. We have had litigation on that point and it was decided to take it at right angles at either end of the road, which was constructed. Our courts settled it in that way.

Mr. Innis—I think in two cases in which I was interested, it ran into the courts and our courts so held.

The President—The second question is "How great is the advantage of rolling a macadam road, and how heavy should the roller be for best results? How well do stones retain their places after being rolled, there being no other or top coating placed upon it? W. S. Fox."

About five years ago I urged on the city council of Toledo that they buy a steam road roller. We had made a few macadam roads on the outskirts of the city and there had been considerable difficulty in settling the roads. They had been made without any rolling. We made about three miles of road and I watched with a good deal of interest, and sometimes with a good deal of fear, the results of the traffic on these roads for the first thsee months in a very dry season, and when I saw the wheels cutting down into the macadam, although there was an inch and a half of gravel placed on top, cutting down four or five inches,

got a little nervous and I anxiously wished for rain, and as soon is rain came I made it my business to go over these roads again ind I saw a decided improvement. I watched the thing through he fall, and by the next spring the roads had generally got pretty vell settled. There were a good many ruts in them, but the oads got into a very good shape after a while. The council oncluded my advice was good and bought a roller, and we have uilt several roads since. We have a little trouble sometimes, ut that comes in the dry weather. When a road has been well olled on top and the bottom also, for that matter, the wheels on't appear to cut into the metal as they do when it is laid on oosely. The greatest trouble I found lately, is in the wet weather, vhen the mud and clay are carried onto the road by the wheels of vagons coming off clay roads and are deposited right near the junc- ion of the road; and you will find little hillocks every few feet, ive or six inches in height, and between them a depression. Those hillocks are composed of clay and top dressing on the oad, and the greatest difficulty we have dow is the rut matter. don't know that we can ever get rid of that except by building tone roads entirely and getting rid of the mud roads. But I hink the roller has paid for itself in rolling the macadam roads.

Mr. Dun—What weight is the roller?

The Presieent—The roller we purchased is a ten ton roller. wouldn't advise you to get a heavier one. Sometimes that nakes a great deal of trouble when it gets into a soft spot.

Mr. Colby—We built some macadam roads last year and we ad in our specifications that the roller should be ten tons weight. The contractor laughed at us for the idea of using a ten ton rol- er, and tried to convince us to put it down to three tons. When e brought it there it was one of those common land rollers vhich the farmers use in their fields. I don't think it weighed ver a ton and a half, and I don't think it did much good.

The President—That simply smooths over the surface.

Mr. Innis—As to the latter part of that question, Mr. Presi- ent, I think the better the stone is, that is, the harder it is, the nore necessity there is for it to be crushed somewhat fine. If eft too course and nothing put on top it won't cement, or not in reasonable time. I doubt if it ever will. This road I spoke f in Union county was made of blue limestone. It was quite ard, but it was all crushed so that it was coarse and, though it ad been on there a year or two, it was loose. I could hardly rive a buggy over it. I would just as soon drive over a sand ed where the buggy would sink three or four inches. In fact I ould scarcely get my horse out of a walk until he struck this

other road I spoke of in Franklin county, where the stone was crushed finer, and there he started off at ten miles an hour. I think if we want to make a good road, the stone must be crushed fine enough so that it will cement itself, or we must put something on it so as to cement it together. At the crossings of the mud roads you spoke of I found, where the mud was carried onto it, that the road was much better, until the mud got shaken off. There would probably be a hundred feet at the crossings, including the crossings, both ways where the road would be passable. Then again the stones would slide under the horse's feet and under the wheels of the wagon.

The President—For my own part I would not think of building a stone road without putting on a top dressing of either spalls or, what I think is better, bank gravel, fine bank gravel.

REPORT OF COMMITTEE ON SURVEYING.

To the President and Members of the Ohio Socity of Surveyors and Civil Engineers:

The undersigned, chairman of the committee on surveying, submits the following: Circulars were sent out to the members of the society, requesting them to send us such questions, problems, or other material as would help to make a report, at our next meeting, as interesting and instructive as possible; responses were received from three members of the society; only one of which furnished any material for said report. Special communications were sent out to the other members of said committee for suggestions and material for our report with the same result. I persume professional duties interfered.

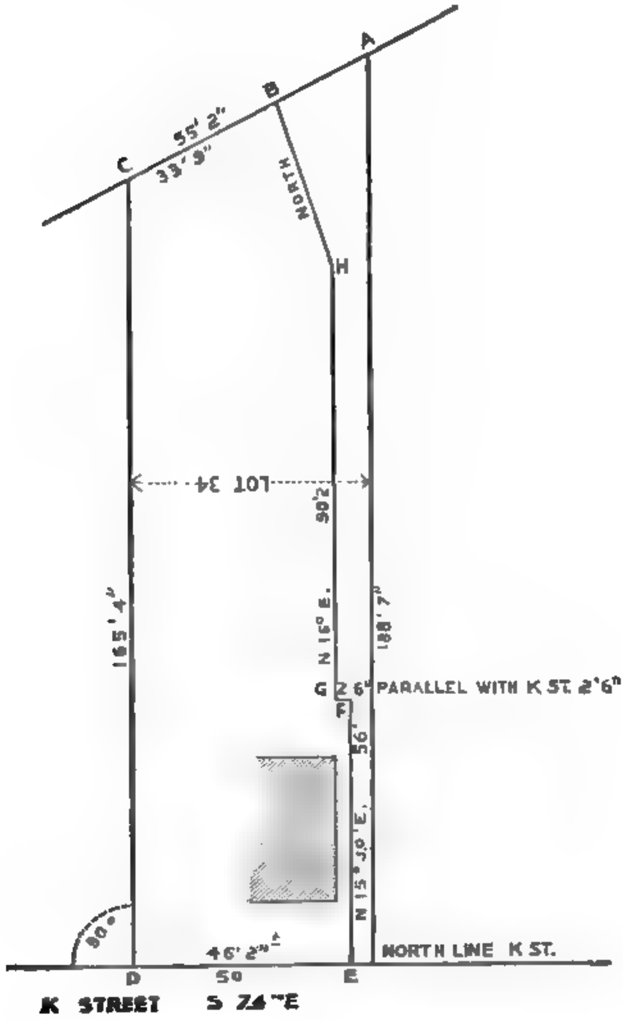
The following problem No. 1—received from J. D. Varney:

The A. W. W. sub-division gives the course of K street as S. 74° E., and describes the lot lines as running at right angles to the street. In 1864 A. conveys to B. by the following description: Being the westerly part of lot 34 in A. W. W's sub-division, bounded as follows: Beginning at a point on the northerly line of said lot 33′ 9″ from the northwesterly corner of the same. Thence westerly 33′ 9″ to said N. W. corner. Thence southerly along said westerly line to K street. Thence easterly along northerly line of K street about 46′ 2″ to a point 2′ 5″ easterly from the east line of a double brick house on said lot. Thence N. 15½° E. parallel with the east wall of said brick house 56′. Thence

westerly parallel with K street 2′ 6″. Thence N. 16° E. 90′ 2″. Thence north to the beginning.

In 1891 C, having title under B, removes the "double brick" and commences the erection of a brick structure to the lines. Previous to removal, references were taken so the position can be reproduced. The only question to be considered is as to the direction of the line G. H. called in the deed N. 16° E. 90′ 2″. The point G. being agreed upon. 1st. Shall the N. 16° E. of the deed be constructed as at right angle to K street S. 74° E.? 2nd. Shall it be governed by and deflect ½° from E. F.?

PLAT OF J. D. VARNEY'S PROBLEM.

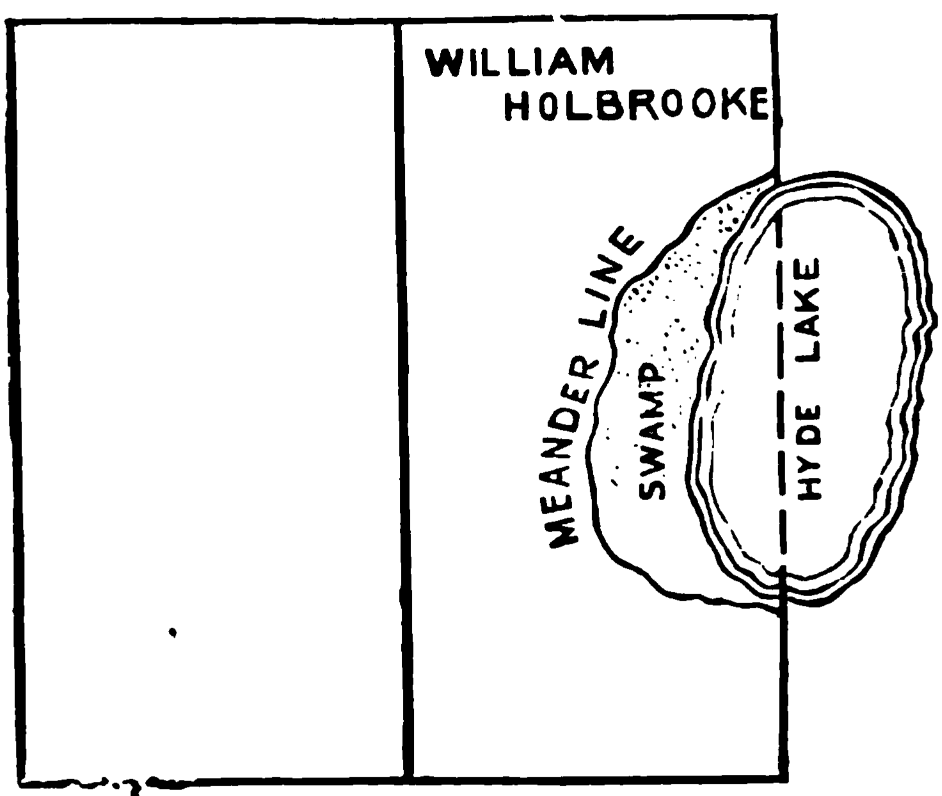


An important decision was rendered by Judge Gresham, in the United States Circuit Court, in what is known as the Wolf Lake cases, which have been in *litigation* for a number of years. The cases included three suits of Ouster brought against United States Treasurer Jordan.

In 1835 Mrs. Hardin's father, William Holbrooke, now deceased, purchased three tracts of land west of Hyde Lake, a small basin of water, the tract being in the northeast quarter of sec. 19, and their eastern boundary being the lake. Holbrooke occupied the land up to a *meander* line down along a ridge of high land. Between this line and the lake shore was an impassable swamp which has since been recovered and purchased from the government by the defendant. The complainant claimed that when the governnment deeded the land it intended that the lake shore should be the permanent boundary line, and not the *meander* line which was made on account of the inability of the surveyor to perform his work in the swamp. The court confirmed the claim.

When a navigable stream is meandered in making the public surveys and the U. S. has guaranteed to the *meander* line, the guarantee takes to the river. The stream and not the meander line is the true boundary of the riparian owner.

Minto v. Delaney, 7 Oregon R., 337.



SECTION 19.

The bill now being discussed by this society, "To define what shall constitute a legal description of land", is a subject worthy our attention. Mr. Hill's bill as a substitute for the Stephens bill is a move, I think, in the right direction. All descriptions in deeds should give county, range, township, section, quarter, and lot, and,

actional parts or sub-divisions, course and distance, which ld close if computed or protracted. It should be so described the premises conveyed could be located by any surveyor, not left so indefinite that the neighbors would have to be d in to find the land, which sometimes *occurs.*

The subject of the examination and licensing of surveyors, ch has many good features, will propably be discussed his meeting. I think a similar examination and licensing onveyancers would also weed out a number of incomnt persons. The law presumes that any person elected he office of Justice of the Peace is a *competent* person draw up instruments of conveyance, although he may no knowledge of the location or description of land, experience in that direction; consequently there are y cenveyances put upon record that convey nothing and are hless. Hence arise so many cases in litigation.

The following description of a parcel of land which I am fair with fully illustrates the incompetency of a certain justice attempted to draw a deed from a plat and survey of said nises. Commencing in the center of——road on the north of lot number——; thence N. 89½°W. 16 poles; thence 9½° E. 12 poles; thence N. 33½°E. to the place of begin-

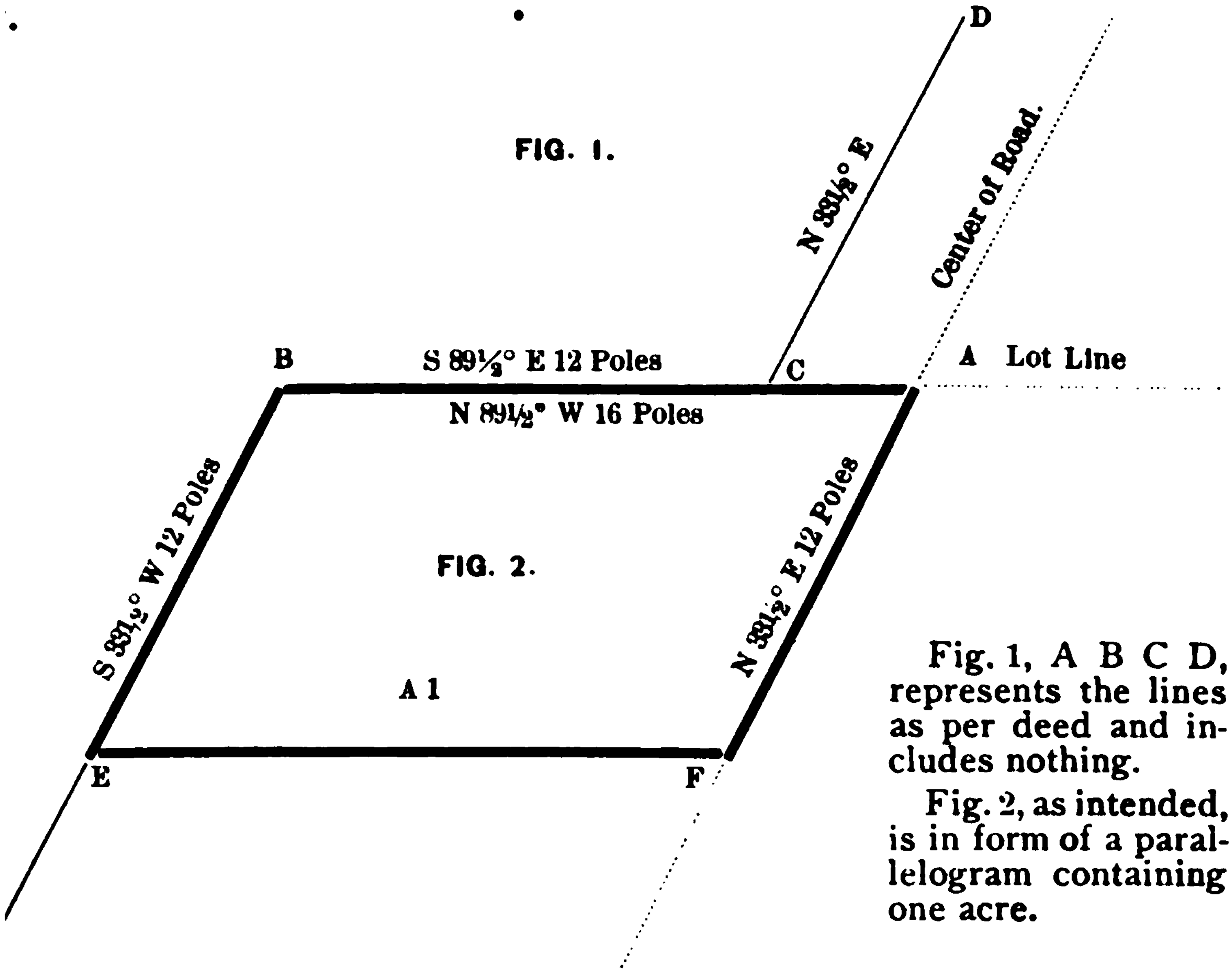


Fig. 1, A B C D, represents the lines as per deed and includes nothing.

Fig. 2, as intended, is in form of a parallelogram containing one acre.

Respectfully submitted,

J. T. Buck, Chairman.

their interests, as we have known them, they can take advantage of any letting; but as a rule each company wants to dispose of its goods, and under the law the engineer is almost compelled to make the estimate higher than he thinks it should be in order to insure a sale of the ditch, when if it were left to his better judgment, if he be honest, the result might be very different. Besides the commissioners need not approve the sale where it is apparent that undue advantage has been taken; and what is true in one county in this respect is applicable to all.

The county ditches in this county, taking into account the locations and times of cleaning the same, will amount to about $60,000, and the township ditches will be fully that, if not more.

The costs of some ditches have been a great source of complaint, and under the present law there seems to be no remedy, unless it be amended to allow the engineer a fixed sum per hundred feet for location and to superintend its construction, including his assistance. The writer has known tile ditches where the costs exceeded $1.50 per station, and the largest tile was only ten inches.

The sale of ditch bonds is often abused, under the present law, compelling the parties to pay interest on the bonds for at least six months, in some cases, before any work is done. Putting in large tile from twenty inches to twenty-four inches has been a serious question in Preble county, because of the cost, and also the doubt whether they will prove to be practical in all cases, and will resist the pressure as well as smaller tile, as greater difficulty is experienced in keeping them perfect in making.

The report of D. W. Pambell, of Shelby county, is as follows: "There is no exact record kept of the number and extent of the ditches, in this county, located under the drainage laws of Ohio. This is a ditch county, although occupying a part of the highest table lands in the state, the water in our ditches flowing into both the Gulf of Mexico and the Gulf of St. Lawrence. On this plateau rises the head waters of the Great and Little Miami rivers, Scioto, Madriver, Stilwater, and Wabash radiating in all directions, but finally flowing south, while the St. Marys, Auglaize and Sandusky rivers flow north. The north-eastern and south-eastern portions of the county drain into the Great Miami river, the south-western portion drains into Stilwater, and the north-western portion drains into the St. Marys and Auglaize rivers.

The county contains an area of about 400 square miles, not including Loramie reservoir which occupies about 2000 acres.

The bottoms of the rivers and their tributaries are from

twenty-five to 125 feet below the top of the table lands, thus offering a good outlet for all ditches. There are over 200 miles of open country ditches in the county. The general fall of these ditches has a gradient of one-tenth of one foot to the 100 feet. Very few new ditches have been laid out in the last ten years: the ditching consisting in deepening, widening, and straightening old ditches. There is also a considerable amount of county tile ditches, with tile ranging from eight to twelve inches, the latter size being the largest in use now, but we have a ditch in process of location which is to have eighteen inch tile a part of its length. There are many hundreds of miles of private tile drains in the county; some farms of 160 acres having over two miles of tile drains through them. Mr. Pampell further says: The writer often thought it would be a proper thing for our society to recommend to the State Board of Agriculture the adoption and construction of an experimental tile drain field, which might be arranged and constructed substantially as follows: Select a level plat of land with a soil of a nature that will be improved by tile drainage. Measure exactly one square acre, which is practically 208.7 feet on a side. Excavate a trench seven feet deep, and build a stone wall two feet thick, thoroughly cemented, from the bottom of the trench to a few inches above the top of the ground, and let the inside of the wall bound the exact square acre. Then lay parallel lines of drain tile of different sizes, and at different gradients through the field, from the inside of one wall to the opposite wall, terminating in cast iron water pipes of the same internal diameter reaching through the wall, each supplied with a gate valve on the outside of the wall, the drain tile to be thoroughly cemented to the cast iron pipes just inside of the wall, and the outer ends of cast iron pipes to be arranged to discharge at pleasure either under water, or in the open air. There should be sixteen lines of tile, 12.76 feet from center to centre, of the following dimensions; four lines of 3 inch, four lines of 4 inch, four lines of 6 inch, four lines of 8 inch. Each line of the different sizes should have a different gradient as follows:

No. 1 of each size 0.1 of one foot to the 100 feet.
No. 2 of " " 0.2 " " " " 100 "
No. 3 " " " 0.3 " " " " 100 "
No. 4 " " " 0.5 " " " " 100 "

The upper end of each line should be three feet below the surface to top of tile. After inundating the field with water any one of the lines could be opened, and the progress and result of the discharge noted. A comparison could then be made of the different sized tile under the different conditions of fall and outlet,

also the best and most economic length of the sections of tile, and best manner of joining them together, whether with plain ring or socket joints.

In the same field many valuable tests and observations could be made with fertilizers, the extent and effect of moisture and temperature upon germinations and growth of crops.

The writer does not know to what extent such experiments and observations have been made, but he does know that there is need of more information on this important subject of drainage. With such an experimental field, valuable data and information for the farmer and drainage engineer would be obtained.

For the flow, velocity and discharge of water through rivers, canals, streams, etc., and through sewers and smooth cylindrical cast iron pipes, we have the observation and data furnished by such engineers as Weisbach, Poncelet, Trautwine, Haswell, etc., but we have little information and experience in regard to tile drainage. Every engineer has some rule for determing the size and capacity of drain tile suitable to a locality. But all feel the need of more information, and better methods for obtaining the desired results in this branch of engineering.

It is not necessary here to undertake an explanation of the great benefits of tile drainage to agriculture. Its effects in the districts of the State needing tile are already producing millions of extra bushels of grain annually, and its effect will be constantly increasing. Respectfully submitted,

F. M. Davisson, Chairman.

REPORT OF COMMITTEE ON CIVIL ENGINEERING.

Mr. President and Gentlemen:

When notified of my appointment as chairman of this important committee I was so busy and had so many things demanding attention I scarcely had time to say *no*, nor had I time to write a respectable declination. At a later date an excuse might have been written, had it not been for the advice of an old friend, to whom I have often gone, who said to me—young man, never shirk any duty or work asked of you, no matter what you may think of your ability, so long as those who are your superiors, believe you competent or capable of doing it.

So your humble servant graciously accepted the situation, and very soon thereafter sent letters to his associates on the com-

mittee, with a request to each to prepare something for the association, which papers would form a part of the report. By the foregoing method a most valuable set of papers could be presented by members of this committee and leave the chairman to reap the glory. With this conviction the chairman settled down to his work and gave the work of his committee little thought until this meeting.

Before offering anything of my own, let me call your attention to the most excellent report of the committee on civil engineering of last year as printed in the proceedings for 1891. Remember, a good thing loses nothing by repeating, whether written or spoken, so please read the last report on civil engineering, since the little I may offer at this time will be more in the nature of a supplement to that report than an attempt at offering anything new. Not that there are no new fields of investigation which have opened to the engineer, for at no time in the history of the world have themes of greater interest or importance to mankind been brought forward than have been within the past few years.

No field of research has given to the world more important results than that of civil engineering. A mighty wave of improvement is sweeping over this vast country; vaster than anything heretofore known or even dreamed of. Stupendous works have been conceived by the engineer in earth and sea and sky.

A young Franklin has been engaged for a few years past in demonstrating to the world some of the possibilities of electricity, and it now looks very much as though the next decade will witness a grand revolution in the "transmission of power." It will be remembered Mr. R. Frank Hartford, a former member of this society, in an admirable paper on "the transmission of power" set forth the advantages which electricity possessed over steam or compressed air, and spoke of the vast power that might be utilized from the waters of Niagara Falls for generating electricity. Now comes an engineer who proposes a gigantic scheme for running railroad cars from the Atlantic to the Pacific by means of electricity, which is to be transmitted from accmulators at Niagara to suitable places for this purpose. What the future shall reveal in this line, not even the most aggressive engineer has ventured to predict. He says wait and see. If we might venture a comparison of what the possible future shall be as compared with the past, in this comparatively new field of research, we might say that insomuch as the greatest accumulation of arc lights surpasses the oil taper of olden times, so shall the achievements in the future for electricity outshine the works of today. But why conjecture?

We may speak now of some of the other improvements which are bringing health, comfort and pleasure to the inhabitants of our cities and towns.

First, we may remark, that a great improvement is noticeable in the laying out of town plats, in that they may the better comform to public improvements.

Streets should be of greater width than they are usually laid out. A town or city with lots running from 160 to 200 feet in length and streets being but thirty or forty feet wide, we should pronounce faulty. With a distance of 400 feet between street centres, the streets should be about eighty feet wide with a dividing alley twenty feet wide, which would leave the length of lots 150 feet. This arrangement would ordinarily give fair distance between fire hydrants and for arc lights. The width of street would also be ample for accommodating a double track street railroad which, in this case might be located in the centre of the street.

The streets, so far as possible, should be uniform as regards distances between centres, and all cross streets should, where practicable, cross at right angles, with no jogs. This last mentioned defect is very apparent to the engineer who is called upon to prepare plans for lighting, or for water works, or for sewerage. Very especially important is this in respect to lighting and for street car service; is also better, and more economical, in the construction of water works and sewers.

Cross streets might be from fifty to sixty feet in width, and where street car tracks are required they could be located on one of the street lawns rather than in the middle of the street. There are various reasons for placing street car tracks to one side, where the streets are narrow. A track is much easier maintained when it is free from the wagon road, and the street is kept in better repair when it is free from street car tracks, to say nothing of the nuisance of having car tracks to drive over with wheeled vehicles. In fact there seems to be no good reason why street car tracks would not be better, in almost all cases, if laid to one side of the street, and off of the driveway.

The year just passed has probably witnessed the building of more public works than any preceding year in our history. More water works, which means better health, less mortality and fewer doctor bills. More electric light plants, which are rapidly taking the place of gas and other systems of lighting. More sewers, which means added conveniences, comfort and improved health. More street railways, which means added luxuries in travel, convenience and comfort, and in many ways economy; as

by them cheap conveyance is furnished to the suburban parts of many of our cities where the merchant and mechanic may enjoy the comforts of larger space, purer air, and cheaper grounds. More permanent street pavements were laid, probably, than in any former year, which have added largely to the comfort and healthfulness of our cities and towns, with a tendency in our large cities to the use of asphalt for road purposes, and for towns and cities of lesser dimensions, the use of vitrified brick. As to what road metal should be adopted depends largely upon circumstances and the requirements. For comfort, cleanliness, durability and healthfulness, all combined, probably nothing surpasses sheet asphalt. Space will not permit us in this report going into a general discussion of street paving.

In conclusion we would say that much is being done to improve the sanitary condition, as well as comfort and general usefulness and convenience of our towns, villages and cities; and so far the taxpayers, as a general thing, seem willing to bear the burden, if such it could be called. For this reason we are anxious to have the oversight of our water supplies throughout the State placed in the hands of the State Board of Health, as is now done in Massachusetts; believing that only in this way can uniformly pure and wholesome water be obtained. We would therefore urge the passage of such acts by our legislature as shall most effectually secure this much desired end.

J. B. Strawn, Chairman of Committee.

Mr. Strawn—I would say that it is the request of the State Board of Health through their secretary, Dr. Probst, that this association take some action favoring the placing of the inland waters of our State under the care and supervision of the State Board of Health, as is done in Massachusetts, so that no system of water works or sewerage, or city drainage, could be adopted except as permitted and recommended by the State Board of Health. I will say that a bill was formulated last winter upon this subject and presented to the State Board of Health, and from the State Board of Health it went to Governor Campbell, who gave the bill his careful consideration; that bill is in the hands of the president of the State Board of Health, and it is the request of Dr. Probst that this society take the initiative step looking toward the enactment of a law similar to that of Massachusetts. I would move you, therefore, that it is the sense of this meeting that such legislation should be secured as shall practically place the inland waters of our State, which are utilized, or may be utilized, for domestic supplies, under the care and supervision of the State Board of Health.

A Member—I second this motion.

Mr. Strawn—Having for a few years past been almost constantly engaged in the matter of looking after water supplies and the construction of water works, I will say that we are troubled when we reflect that many of our streams, which from their location, volume and natural utility, would be very desirable for water supplies, are made almost absolutely unfit for water supply by reason of the vast amount of sewerage and refuse that find their way into these streams. Take the Mahoning river for instance. There is Alliance, with a population of 7,000 or 8,000, draining into it. There is Warren, with a population of 7,000; Niles, with a population of probably 4,500; Girard and part of Youngstown. Here are all these towns with their sewerage emptying into this river, and at low water at Youngstown, the river is hardly sufficient to supply the city. This is only one instance, a dozen rivers in the State are in the same condition. I should be glad to see our society take the first step in procuring a better quality of water than we are capable of doing in some of our cities at the present time.

The President—Mr. Strawn's remarks bring back to my mind a statement made this morning that the rivers were the natural highway of commerce. They were at one time. They are now the natural highway of sewerage, and the sooner we get beyond that, the better. The city of Toledo will some day have a serious problem on hand. The Maumee river, after passing through the cities of Fort Wayne, Paulding, Defiance, Napoleon, Maumee and Perrysburg, with one or two smaller towns on its banks, flows through Toledo. The large majority of the sewerage of the city of Toledo flows into the river below the intake of the water works. One of our main sewers is situated about three-quarters of a mile below the intake. There are times when we know that the water from Lake Erie, which is ten or twelve miles distant, reaches the upper part of our city. We know that in this way, that so long as the water of the river is supplying the boilers of a certain large manufacturing establishment, they have little or no trouble from scale. Whenever the lake water gets into this boiler the scale becomes hard and baked like stone, and the thing occurs at some time during nearly every season. Personally I feel that it is a matter that the city of Toledo ought to attend to at once, and the city of Toledo is only one of a great many examples. I personally favor this resolution and hope it will pass. Are there any further remarks?

The question coming on the motion of Mr. Strawn, it was carried unanimously.

REPORT OF COMMITTEE ON BLANKS AND INSTRUMENTS.

To the Officers and Members of the Ohio Society of Surveyors and Civil Engineers:

In compliance with the request of your secretary, your committee on blanks and instruments has collected a large number of blank specifications from the largest cities of the United States. Embracing and defining, as they do, the best practice, and the matured experience of the best engineers of our land, these papers are of inestimable value.

To prepare any adequate report of these papers would make a document so voluminous as to be inadmissable in the annual report.

We trust that the society may soon secure permanent quarters where these and other valuable papers may be kept on file and made available to all our members.

Respectfully submitted,

L. W. MATHEWSON, Chairman.

Mr. Mathewson said:

I have endeavored to collect a number of specifications of street and sewer works from some ten or eleven of the largest cities in the United States; to read through these specifications and compare them, and to select from them such information as I thought might interest the members of the association. But how to present this matter now in such a way as to be of any interest is certainly very difficult; to take up these specifications and read them one after another would take all the time of this convention, and more too. I have received from Louisville specifications which are gotten up in this form. They are handy little pocketbooks. They are not prepared in this form for regular use in that city in getting up their contracts, but are prepared for the use of the engineers and inspectors, and perhaps members of the board of public works,. and councilmen, so that they may be easily carried in the pocket. Specifications for asphalt streets, specifications for granite streets, vitrified bricks and blocks, and also specifications for sewers. I also find in the back part diagrams illustrating exactly how the streets are constructed, and the manner of laying the brick; manner of laying the granite blocks, street car tracks, and everything of that kind.

REPORT OF COMMITTEE ON LEGISLATION.

Mr. President and Gentlemen of the Society:

Your committee on legislation beg leave to submit the following report: During the last session of the last legislature, but two bills, known to the committee, were introduced that in anyway directly affected the land surveyors and civil engineers. One was in regard to the description and monumenting of land surveys, and the other in regard to the county surveyor also being the county civil engineer. The secretary of the society sent out a circular in regard to the last, which circular you all remember. Both of these bills were defeated.

A short time before this meeting two proposed bills came to the hands of the chairman that must be noticed, one from Mr. Hill and another from Mr. Kemper. Both bills are for the same purpose as the bills that failed last winter before the legislature, and which referred to description, etc., of land. These bills were drawn so as to, if possible, avoid the objectionable features of the bill that failed. Both bills contain many good points, and either, or a new one based on these, would no doubt be of great benefit to the land surveyors of the State.

But in view of the action of the society at this meeting, in regard to the proposed bill in regard to the examination and issuing of certificates to land surveyors: your committee does not think that it would be wise for the society to be interested in or to recommend to the legislature any other bills at the present time.

The committee believes that it will take a strong and united effort on the part of the entire society to bring the "examination" bill to a successful end, and that we ought not to divide our forces.

At a future day, after the "examination" bill is in operation, the committee thinks that a bill similar to these two proposed ones could be passed without very much effort.

Respectfully submitted,

C. N. Brown, Chairman.

REPORT OF SPECIAL COMMITTEE ON PREPARING A BILL REQUIRING SURVEYORS TO BE LICENSED.

To the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN:—In your consideration of the following act, providing for the examination and registration of land surveyors, herewith submitted by your committee, and which had been prepared under instructions from you, we trust that you will remember that for the last thirteen years, or since the organization of this, the pioneer state society of surveyors, there has been an act annually prepared (or at least discussed) with a similar end in view by one or more of our sister organizations; and there have been many such acts that have been presented to legislative bodies and remodeled by the committees of such bodies, but that none of such acts have acquired the dignity of a statute.

Two or three points are then apparent in taking up this question. First—There is, without doubt, a crying need of reform in this direction. Second—The manner and method by which it is attempted to be brought about should be gravely and deliberately considered. Third—There has been up to this date, in all states in which similar efforts have been made, a powerful and successful enemy that has so far succeeded in defeating all movements of this character. Among the states whose law-makers have considered such legislation are notably those of Pennsylvania, Illinois, Colorado, and Iowa.

The chairman of your committee has personal knowledge of the high professional character of the gentleman who, some ten years since, submitted a bill to the Pennsylvania legislature, and witnessed, with hope and pleasure, the unanimity of opinion and enthusiasm that pervaded their meeting to discuss their measure.

He also believes that in that state, as well as in the State of Michigan, the successful opposition was from the tricksters and wire pullers of our profession; whose aim and object were as selfish as their methods were reprehensible.

The responsibility of an effort to overcome such a foe must rest with you gentlemen: it is active and ever present, as you well know. In the preparation of the plan here outlined your committee have had before them copies of the acts heretofore referred to, as well as that in operation in Canada; also those sections of the statutes of Ohio regulating the practice of medicine and the sale of drugs. They desire also to acknowledge obligation to Mr. Paul, of Cuyahoga Falls, Messrs. Varney and

Brown, of Cleveland, Mr. Strawn, of Salem, and other members of our society for suggestions offered and criticisms made; and the matter is placed in your hands with the hope that you may mould it into such finished and practical shape, and give it such active and energetic support as will secure the successful accomplishment of the end in view.

Committee. { C. H. Burgess, T. R. Wickenden, C. N. Brown.

The bill reported by the committee was thoroughly discussed by the society and amended in several important portions. After being revised by the committee and by the Civil Engineers' Club, of Cincinnati, which consumed some time, an attempt was made, by Mr. Burgess and others, to push the measure through the legislature. Considerable opposition developed as things proceeded, and it was only through the persistency of Mr. Burgess and the kindness of Mr. Gear that it was finally introduced in the senate and ordered published.

The experience of the committee revealed the fact quite clearly that to secure the passage of this or any other measure of the society, necessitates the organized and persistent effort of a large number of the members, who shall be willing to work for the passage of the measure. Following is the bill as introduced, and now before the senate:

70th General Assembly, Regular Session. S. B. No. 321

Mr. Gear.

A BILL

To establish a state board of surveyors, and to provide for the better regulation of land surveys in the State of Ohio.

Section 1. *Be it enacted by the General Assembly of the State of Ohio,* That the governor be and he is hereby authorized and directed, as soon as practicable after the passage of this act, to appoint three competent surveyors who shall have been for ten or more years immediately preceding their appointment reputable citizens of the State of Ohio, and for the same period continuously engaged in the business of land surveying and civil engineering; who, together with the professor of civil engineering in the Ohio State university as an ex-officio member, shall

form a "board" to be known as the "Ohio State board of surveyors." The members first appointed shall be designated by the governor; one to serve for two years, one to serve for four, one to serve for six years from the first Monday of January succeeding the appointment; and thereafter a member shall be appointed by the governor biennially for a full term of six years, beginning the first Monday of January. Any vacancy among the appointed members of said board shall be filled by the governor for the remainder of the unexpired term.

SECTION 2. Each member of said board shall take the constitutional oath of office before some officer authorized to administer oaths, and shall enter into bonds with the State of Ohio in the sum of one thousand dollars, with sureties to be approved by the governor, conditioned for the faithful and impartial performance of the duties of his office, and shall file such bond and oath of office in the office of the secretary of state.

SECTION 3. The appointed member of the board whose term of office shall soonest expire shall be president thereof; three members shall constitute a quorum, and regular meetings shall be held twice per year at the capital of the state, beginning the first Monday of January and July of each year. Special meetings may be held when deemed necessary at other times and places within the state. The duties of the president shall, in his absence, be performed by an acting president, who shall be that appointed member of the board whose term of office shall expire next in order to that of the president; and the said acting president is hereby clothed with all the power and authority that are elsewhere conferred upon the president of this board.

SECTION 4. Any person twenty-one or more years of age, of good character, may appear before this board for examination and registration at any regular or special meeting. It shall be the duty of this board to examine all applicants in a practical manner as to their knowledge of such sciences and arts as, in the judgment of said board, pertain to the correct practice of land surveying in the State of Ohio, and issue certificates of registration to those who, after examination, shall be regarded as competent; who, when so registered, shall be known as "Ohio land surveyors." The said board shall formulate such rules and regulations for the practice of land surveying as will conduce to uniformity of practice, insure the most accurate and satisfactory work, and lead to the fixing of permanent boundary monuments; they shall arrange a uniform system of making and preserving field notes, maps and records of all surveys; which rules, when approved by the board, shall be printed by the secretary of

state, and a copy of the same furnished to each Ohio land surveyor, who shall be governed by the same; and said board shall act as an advisory board upon difficult questions of surveying practice that may be submitted to them by Ohio land surveyors. The board shall also make such rules and by-laws as may be necessary for the proper discharge of their own duties; they shall keep a full record of all their proceedings, an itemized account of all moneys received and expended, and a list of all certificates granted, or revoked, or expired under this act. The appointed members of this board shall receive the sum of five dollars per day for all time necessarily employed in the discharge of their official duties; and all members shall receive all necessary expenses, including clerk hire, to be paid from the fees and penalties received by the board under the provisions of this act, after itemized bills for the same shall have been approved by the said board and the secretary of state. Any funds received by this board in excess of the approved annual expenditures shall be held by them as a special fund for meeting future expenses. Applicants for future examination shall pay a fee of five dollars before each examination, and when successful shall pay an additional fee of fifteen dollars upon receipt of certificate of registration.

SECTION 5. The president of the board shall, after the delivery of a satisfactory bond and the payment of the required fee by any successful applicant, administer to the applicant the constitutional oath of office, which oath the president is hereby authorized to administer, and deliver a certificate of registration, and the delivery of any such certificate shall authorize the holder thereof to act as an Ohio land surveyor until the same shall expire or be revoked for cause by the board, provided, that such oath of office may be administered by any officer authorized to administer oaths. Such certificates of registration shall be valid for five years from the date of their issue, unless sooner revoked, and the holder thereof may, at any time, renew the same for an additional period of five years, without examination, by filing a new bond and paying a fee of one dollar. The board shall send to the auditor of each county in the State of Ohio at the close of any meeting at which certificates of registration were issued or revoked, a list of successful applicants, which list shall contain the name and postoffice address of the holders, and of their bondsmen, and shall inclose therewith a list of all certificates revoked by them at said meeting or that have expired since their previous meeting.

SECTION 6. Copies of all records, documents and papers in the office of the board, when duly sealed and certified by the

president or acting president, and authorized secretary of the board, shall be received in evidence in the several courts of this state in all cases where the original records, documents and papers would be admitted in evidence.

SECTION 7. Every successful applicant for registration as an Ohio land surveyor, or for renewal thereof, shall enter into bonds in the sum of two thousand dollars with the State of Ohio, conditioned for the faithful discharge of his official duties, with sureties approved by the auditor of the county wherein the applicant resides; which bond, after having been delivered by the applicant to the Ohio State board of surveyors, and accepted by them, shall be placed on file in the office of the auditor who approved the same.

SECTION 8. Any person of lawful age and of good character, having been continuously engaged in the profession of land surveying, or land surveying and civil or mining engineering for the period of five years in the State of Ohio, or who shall have received from a school or college authorized to confer such degrees, the degree of civil or mining engineer, and for at least two year's immediately preceding their application have been engaged in the practical work of the aforesaid professions in the State of Ohio, shall, upon satisfactory presentation of such facts to the Ohio State board of surveyors, submitting a bond as provided in section 7, taking the constitutional oath of office, and paying a fee of fifteen dollars, be entitled to a certificate of registration as an Ohio land surveyor, without examination; provided, such application shall be made to the board within two years after the passage of this act.

SECTION 9. It shall be the duty of every Ohio land surveyor to place on record with the county surveyor of the county within which said Ohio land surveyor may be called upon to make any survey, a complete plat of the same, within ninety days from the date of execution of said survey; said plat of said survey to be in such form and detail as may be prescribed by the Ohio State board of surveyors. The said Ohio land surveyors shall receive payment out of the county general fund from the commissioners of the county within which the land surveyed lies, for their services as prescribed in this section, at the same rate allowed the county recorder for transcribing similar plats; and it is hereby made the duty of the county surveyor with whom said plats shall be filed, to index and preserve the same in book form in such detail as may be designated by the Ohio State board; and such plats or copies of the same, duly certified by the county surveyor, shall be received in any court in this state as prima facie evi-

dence of the facts thereon set forth. It is also made the duty of each Ohio land surveyor to keep in his possession, for the purpose of comparison only, a steel tape not less than one hundred feet in length, properly graduated, the exact length of which, and true distance between such points of graduation have been certified by the bureau of weights and measures of the United States coast survey.

SECTION 10. After two years from the passage of this act, it shall be unlawful for any public officer in the State of Ohio to make a record for public use, of any plat, of any survey of road or land lines, or of any sub-division of land into lots or parcels, unless the correctness thereof shall be certified by an Ohio land surveyor, or a county surveyor or his deputy; or, unless the survey shall be of a line or lines seperating the land of two or more parties, and was made by mutual consent of all the parties, reduced to writing and signed by them all. After the passage of this act it shall be unlawful for any person to misplace or disturb any mark or monument placed by any county surveyor or his deputy, or by any Ohio land surveyor upon any land line.

SECTION 11. Any person who violates any of the provisions of this act shall be deemed guilty of a misdeamor, and upon conviction thereof, shall be fined not less than ten dollars and not more than one hundred dollars; and fines so collected shall immediately be turned over to the Ohio State board of surveyors, to be used in meeting the necessary expenses incurred under this act by said board. It shall be the duty of said board to cause the prosecution of all persons known by them to have committed such offenses.

SECTION 12. No Ohio land surveyor shall be liable to prosecution in an action for trespass for going upon any lands at any reasonable hour, and accompanied by any necessary assistance in the discharge of his duties, and he shall receive the same protection thereon as is now by law accorded the county surveyor.

SECTION 13. No person shall be eligible to the office of county susveyor or be appointed as a deputy therefor in the State of Ohio, unless he shall be at the time of his election or appointment an Ohio land surveyor in possession of a valid certificate of registration.

SECTION 14. All acts or portions of acts conflicting with the provislons of this act, are hereby repealed; and this act shall take effect and be in force from and after its passage.

REPORT OF THE TREASURER.

COLUMBUS, OHIO, February 3, 1892.

he President and Members of the Ohio Socity of Surveyors nd Civil Engineers:

ENTLEMEN:—I herewith submit the following statement of eceipts and expenditures of the society during the year end- Feb. 3, 1892:

RECEIPTS.

f Annual Reports,	$ 12 44	
ership Fees,	27 00	
al Assessment for year 1888	3 00	
al Assessment for year 1889	6 00	
al Assessment for year 1890	9 00	
al Assessment for year 1891	135 00	
al Assessment for year 1892	129 00	
		$321 44
tirements for year 1890	20 00	
tisements for year 1891	315 00	
tisements for year 1892	1 00	
		336 00
from Julian R. Griggs, Treasurer,		151 00
otal,		$808 44

EXPENDITURES.

ng Annual Report (1891),	$259 40	
s for same.	64 50	
		$323 90
Printing,	12 00	
nery	30 02	
		42 02
grapher's fees, meeting of 1891	56 30	
of Hall, meeting of 1891	25 00	
		81 30
of Hall, meeting of 1892		10 35
ge,	113 09	
raphing,	3 15	
ess, Freight and Cartage,	41 75	
		157 99
ge of Society Property,	12 00	
tant Harold Hovald,	25 00	
nses to Columbus, meeting of 1892	19 30	
		56 30
otal,		$671 86
ce cash on hand,		$136 58

E. D. WILEMAN, Secretary-Treasurer, 1891.

REPORT OF THE BOARD OF TURSTEES.

To the Ohio Society of Surveyors and Civil Engineers:

GENTLEMEN:—We, the undersigned, board of trustees of said society, respectfully ask leave to report that in compliance with our duties we have carefully examined the books and accounts of the treasurer and found them correct. We also fix the annual assessment per member for the year A. D. 1892, at three dollars. Respectfully submitted,

G. S. INNIS, Chairman Board of Trustees.

January 19, 1892.

COLUMBUS, OHIO, January 21, 1892.

The former report having been referred back to your board of trustees, and in view of the fact that the society has agreed to pay its secretary two hundred dollars per annum, we ask leave to submit this, our supplemental report. We now fix the annual assessment per member for the year A. D. 1892 at five dollars. We also, for the reason that Mr. Harold Hovald has, during the year past, largely assisted the secretary in his labor for this society, recommend that he, the assistant, be paid the sum of twenty-five dollars.

Respectfully submitted,

G. S. INNIS, Chairman Board of Trustees.

RESOLUTION OF SYMPATHY.

The following resolution was unanimously adopted by the society at its meeting on January 21st. Following is the reply of Dr. Orton in response to a copy of the resolution sent him by the secretary:

Resolved, Whereas, we this year miss from our meeting the familiar face and beloved form of one who has so many times contributed from his treasury of knowledge to our common fund, greatly to the profit and pleasure of the members of this society, and,

Whereas, our benefactor is now confined to his house by a serious illness, we, the Ohio Society of Surveyors and Civil Engineers, assembled in our thirteenth annual meeting, do therefore tender to Prof. Edward Orton, and to his family, our deep sympathy in his illness, and express an ardent hope for his speedy recovery to his accustomed health, and a long continuance of his useful life.

STATE GEOLOGICAL SURVEY,
COLUMBUS, O., Feb. 1, 1892.

Chas. A. Judson, Esq., Sandusky, O.:

MY DEAR SIR:—Your letter with enclosed resolutions is at hand.

The expression of the Civil Engineers Association is very welcome to me in my enforced retirement from active life. I shall be glad to have my high appreciation of the good will of the society expressed in the minutes, in connection with the resolutions.

I hope to be able to attend future meetings of the society and shall always be glad if I can contribute in any way to the pleasure or profit of the members.

I am rallying steadily from my disastrous stroke.

Very truly, EDWARD ORTON.

REPORT OF COMMITTEE ON NOMINATIONS.

Mr. Strawn—Mr. Chairman, before making the announcement of the candidates, who are, in the judgment of the committee, suitable persons to represent this society, I wish to make a statement. We find by going back a few years that it seemed to be the desire of several of the older members of the society that the office of president especially should be handed around. While it had been customary to give the president two terms, it was thought that it probably would be agreeable to make a little break in that direction and make the term for only one year. I must say, and our worthy president will not listen to what I say now, that every one that I have spoken to, said let us retain our present president. I spoke to our president about that and in his modesty he said he would prefer that we elect somebody else. With the protest of one member of the committee we would respectfully submit the following named gentlemen as candidates for officers for the ensuing year:

For President—C. H. Burgess,

For Vice President—L. W. Mathewson,

For Secretary and Treasurer—C. A. Judson.

For Trustees—G. S. Innis, Julian Griggs, F. M. Kennedy, W. H. Gaffney, J. T. Buck.

Respectfully, J. B. STRAWN,
C. H. BURGESS, Committee.
D. W. SEITZ.

On motion of Mr. Connar the secretary was instructed to cast the ballot of the society for the persons named, and they were thereupon declored elected.

SECRETARY'S REPORT.

Mr. President and Members of the Society:

Our worthy past secretary, Mr. Griggs, stated before the last meeting that it was possible to publish the reports in March, and I took hold of the matter with the expectation of doing so, but "I reckoned without my host," for in my inexperience I expected every other member to be as prompt as myself: the membership list comes first, and I wanted it as full as possible, although I was determined not to include any who were six or more dollars in arrears, so I punched and prodded till I grew tired and gave it up, having had but little success, the majority of the delinquents not having the courtesy to reply and say whether they intended to continue or not; and right here I want to suggest the propriety of adopting a by-law that will instruct the secretary to make a sight draft on all members who are thirteen months in arrears.

The next requisite was to get as many advertisers as possible, for on their number depended the style of the report as to illustration. I started with high hopes of a large list, and solicited from all whom I could reasonably approach, and as you have seen, had fair success, but I could not order the cuts till I was tolerably sure of a good number, and it was some time in April before I reached that point. Then came the difficulty of getting back some few of the papers which the writers had taken home again to put in better shape, and at the same time came a rush of my own personal business, and as all the while the days went by as usual, I found myself in the early part of June before the first batch of "copy" was given to the printer, and then came the full hard winter of my discontent (even if it was summer) for he was not properly prepared for such a job, and his foreman was afflicted with a form of intermittent grip, facts that I was ignorant of till after he had commenced; it is not necessary to detail all the trying circumstances of its slow progress through the mill, in which several times a two page form was run on a job press; it is sufficient to say, that with the exception of a couple of days each at two or three different times the entire delay from June till the appearance of the report was due to the printer and his inadequate force, but that is all over, and I have everything in such shape that there is no possible excuse for the next report not coming out during the first week of March, providing the society will instruct the next year's secretary to require a contract from the printer who takes it, binding him to deliver on the first of March or forfeit all compensation, and that can be done,

for the "copy" can all be in his hands by the first of February.

I have attempted to finish the work commenced by Secretary Griggs of getting the report files of the members complete, and have succeeded in about fifteen cases, there still remains on hand the following list of reports:

							1888	1889
Arkansas							14	10
							1885	1890
Connecticut							2	14
						1888	1890	1891
Dominion of Ottawa						16	15	38
							1890	1891
Illinois							30	40
					1883	1888	89-90	1891
Indiana					5	8	17	40
							1889	1890
Iowa							12	42
				1884	1888	1889	1890	1891
Michigan				30	18	12	12	38
					1887	1888	1890	1891
Provincial of Ontario					3	21	19	40
						No 1	No 2	No 3
Association of the South						40	47	44
							1890	1891
Technic of Ann Arbor							17	10
National Public Work Committee								12
County Manual								15
Constitution and By-laws								90
	1881	1882	1885	1886	1887	1889	1890	1891
Of the Ohio Reports we have	39	97	103	54	96	119	44	224

You will notice that our first, fourth, fifth and ninth are exhausted, and I would beg to recommend a reprint of about one hundred of each of those for use in completing files of members and exchanges.

I have arranged a book in which is recorded, as far as is known, the exact condition of the report file of each member, and it will be a great favor to the secretary if all those who have not already done so, would send in a complete list of all the reports they have on hand.

I have, as far as possible, secured complete files from those we exchange with and completed their files of our numbers.

Of new exchanges I have secured one for full membership with the Association of the South, giving our ninth for their first.

Of single copy library exchanges I have secured the Smithsonian Institute at Washington, the Franklin Institute and the

Engineer's Club, of Philadelphia, the Journal of the Association of Engineering Societies, the Technical Society, of the Pacific Coast, the Denver Society of Engineers, the Society of Western Pennsylvania at Pittsburg, and have some others, as yet undecided. Most of these I secured complete files from, while all dealt generously with us. The clerical work of the year has involved the sending of about two thousand letters and of over two thousand printed circulars of various kinds, making an average of six letters to write, and fourteen envelopes to direct every day of the year.

I was very fortunate in having my business in such shape and in sufficiently small volume that I was enabled to attend to the society work in pretty fair shape, but I cannot do it on the same basis another year, nor could I recommend anyone who is dependent on his regular business for an income to accept the office on that basis.

My whole study during the year has therefore been as to how the matter could be so managed that the business of the society shall not suffer, nor yet anything unreasonable be asked of the members, either as officers or as a body. It is very evident that the first requisite is a paid secretary, and it is very evident that the founders of the society anticipated such a need, as article seven of the constitution says that "The society may provide for the pay of any or all of its officers for their services whenever deemed advisable," and of course such provision can only be made through increased dues, but we cannot expect the members to pay higher dues unless they receive some corresponding benefits by it.

Now the benefits they would secure by the change are:

First, a permanent headquarters in Columbus where each one may feel at home and have a place of appointment to meet anyone he has business with, and find almost, if not quite all, the conveniences of his own private office, not as a favor, but as a right he has paid for.

Second, an engineering library, comprising all the public reports on engineering and kindred subjects, both national and state, the other states as well as our own, and all the current literature of engineering, being about twenty weeklies and fifteen monthlies, to say nothing of the quarterlies and annuals, also copies of papers and literary periodicals that have occasional articles of professional value in them.

You will, of course, say what good will a library like that do us, who are not residents in the city? Very true, and there is where the true value of a paid secretary comes in, for each of you will find coming each week by mail a printed slip or leaf,

giving you an index list of all the matter received in the office during the past week, so that each one can tell in five minutes time whether there is anything there on which more information is desired, and if such is the case, there will be a bunch of postal cards in your desk all printed, ready to receive the date, and one or more numbers, according as there is one or more articles you wish to enquire about, and the secretary, upon receipt of these, answers each one by a concise digest of the article desired, thus giving you the kernel without the chaff; in short, the secretary becomes a paid clerk to each one, to read this library, and give you whatever you want out of it, in the shape you want it, and whenever you want it, without any trouble or waste of time on your part to hunt it out. Again, anyone who will take the trouble to keep the secretary informed as to the character of any particular work he is engaged on will have his attention called to anything the secretary notices as being likely to be of interest or use to him without waiting for him to ask for it out of the index leaf. Again, if there was any work of unusual interest going on within the state, or even in the adjacent states, which a group of members desired to know more of than was being published in the journals, by providing the traveling expenses of the secretary they could have him go there, inform himself fully on it, and report to them. If the trustees, or society at large, deemed the report of sufficient value, they could adopt the same and pay the expenses from the general fund, and there might be such a thing as reports of that kind forming the basis of a monthly publication of considerable interest.

Again, any member desiring information on any particular point not mentioned in the index slips, could write and ask the secretary for it, and, in a few days at most, receive a digest of all that the library contained thereon; or if he desired to read for himself, the secretary would pick out all the books on that subject, insert a series of numbered slips, showing him just where to look and in what order, so as to get it all in logical sequence, send them to him to be retained a reasonable length of time and returned; thus you will see, giving each member, no matter where he was located, fuller and better use of the library than he could possibly get if it were in his own office, and such a library as very few of the members could ever expect to own as individuals.

I will conclude on this point by saying that I could spend an hour in describing in detail the various ways that have occurred to me by which the secretary could make himself useful to the members, all of which would develope in the natural course of events if the change is once made.

In the matter of legislation such an arrangement would put a person right on the ground whose duty it would be to be closely watch all bills presented to the legislature affecting the interests of the profession, and to urge or delay them by all honorable means, according as they were beneficial or derogatory.

Now as to the cost of all this, I feel safe in saying that it can be done for fifteen dollars a year from each member. To many, no doubt, the first thought will be "I cannot afford so much;" but stop and think a moment. You now pay three, the addition is only one dollar per month. Who cannot afford a single dollar each month to keep fully posted on all the current literature of engineering, to get *all* he wants from it just *when* he wants it and not be bothered with more than he wants? That money would but little more than pay for two of the best engineering journals, and by paying it to the society you get the full benefit of *all* that are published at a less cost of time than would be required to read the two properly yourself. I also feel sure that I am within reasonable limits when I say that anyone in charge of construction might frequently save many times that amount by having the authorities overhauled on some subject bearing on his work, and the result sent to him just when he needs it, that being usually the very time he is too busy to read it up himself, even if he had all the books by him.

The question will probably be raised, can all this be done for that amount? and I will say that if a reasonable majority of the members will stand by the change it can be started, and with such a plan actually on foot to draw to, it would be a poor secretary indeed who could not make the membership at least two hundred within the year, and once such a number were secured it could be very successfully run, and I am certain, would be sure of a healthy growth, thus maintaining our proper place as the first and best state society in the country. I do not mention two hundred at all as a probable maximum, but as a very possible minimum. I will not trespass on your patience by any further elaboration of my idea in this report, for I feel certain that I have proven beyond a doubt the possibility of making the change a profitable one to the members, and I hope you will all be on the side of progress when it comes to voting on the measures needed to make the change. I will close by quoting some remarks made by President L. E. Cooley, of the Western society, at Chicago, when he was pleading for a needed step forward.

"If we take courage of our desires rather than our doubts we can carry this proposition through. It is easy to raise all sorts of conjectures, to suppose that all sorts of contingencies may

arise that would defeat the object and so on, but there is one thing that I have learned, that the only way to do things is to *do* them, and if we set out to *do* those things we will *do* them, and if we set out *not* to do them, or have doubts about it, we won't do them."

E. D. WILEMAN, Secretary.

DISCUSSION.

The President—Gentlemen, you have heard the report, what is your pleasure?

Mr. Dunn—I think, as Greely said, the way to resume is to resume. The only way to do that is to do it. If the members feel like going down in their pockets and putting up their money to get their money's worth, the only way to get the thing is to pay for it. I never was much of a man to believe in getting anything for nothing.

Mr. Burgess—I would like to inquire what the present membership of the society is?

Secretary Wileman—The membership is about 120. The actual fully paid up membership is ninety. There are something like thirty delinquents of various degrees.

Mr. Burgess—Do I understand that the secretary has always given his services free of charge to the association?

Secretary Wileman—Practically so.

Mr. Bowen—That has been the case, I believe, with two exceptions. When we started out we did not have the money, and of course, could not pay anything. It was done as a matter of pride at first, and has been kept up in the same way. At the time when Mr. Thompson was secretary, for many years the society felt, and justly too, that Mr. Thompson ought to be paid something, for he had rendered valuable services to the society. And they thought they were in a condition that they could afford to pay him, and I think he agreed to accept $100 a year. The last year, however, that he made up the report, the proposition was made to pay him and he declined to receive it, saying that the society funds were not in a condition to justify it, and he gladly contributed his services again in making up the report. Since then Professor Brown, I believe, for two years contributed his services to the society. After that, Mr. Griggs did the same thing without charge, making up excellent reports. Since then Mr. Wileman has made up our last report, which is an excellent one, as we all know, and if there is anything to compensate him for the services he has rendered, I don't know anything about it.

I have always maintained from the very beginning that the work was more than we ought to ask any one man to do, unless a man has a great deal of leisure time on his hands and can well afford to give it to the society, and is ambitious in that line of work. Otherwise, it is not just to the man who makes the report to render so much service for nothing. I said so to Mr. Thompson, and to those who preceded him, and to Mr. Brown and Mr. Griggs, and to every man who has ever served as secretary. But the thing has continued along, as I have related, without any definite understanding. Now, whether we can get in condition to pay our secretary for what he has done in getting out this last report, I am not able to say. The trustees must determine that. If we drift along in the old way, as we have been doing, I fear we will very soon be out a secretary. The work of the society on the secretary has become so great that it is almost impossible for a man to do it without giving one-fourth of his time to it.

Secretary Wileman—It took about one-half of my time.

Mr. Bowen—That is more than any man can afford to give, when he depends upon his own interest for a living. Now whether the new project will be successful or not, is another thing. It think it ought to be very well considered, not only this afternoon, but this evening, and every other time when we have leisure to talk about it, and let every man be well informed as to what is on hand, so that each man, when it comes to a final decision, can vote intelligently. Now, Mr. Wileman, our secretary, has very clearly stated the affirmative of the case. Now it would be well for each one to cast about in his mind and consider what the other side might bring forth. The only thing that is prominent in mind is the expense that would attend this thing. Our secretary appears satisfied upon that line, and I hope he is right. As far as I am individually concerned, I am in favor of anything that will be for the best interests of the society. Now if it can be shown by the joint opinion of all our members who will consider the matter, that this new project is the best thing or the plan is feasible, and the way clear for raising the money, that would be the thing to do. I am individually in favor of it, because I think I would get my share out of the new move, and I don't know but that every other man could get it out too. Now, when our society was first started, if I remember rightly, it was for the purpose of broadening the foundation and elevating the standard of the society, and to that end we have all been working ever since. Whether this plan would have a tendency in that direction I do not know. It might possibly be that some would look upon it as a kind of intelligence office and treat it in

that way. I think there are members in our society who have, by hard work and the most persistent application, become quite proficient in their special line of the profession, and possibly they would not need to draw upon the secretary or upon the intelligence office, as we might call it. Well now, that class of men might not come up with the alactrity that some other men would. We all know that the zeal of aspirants is quite phenomenal at the present time, and for such this would be a good thing. A man could devote his leisure hours to politics and the more congenial pursuits of life, and when he wanted to know anything about his business he would write to the secretary and have it returned by the next mail at a very little cost. Whether that would be encouraging for the profession or not I don't know. These are only things that occur casually to my mind. Whether there is any foundation for it, or whether other men would think of that, or attach any importance to it, is another question, but as they are questions that might possibly arise, they are at least worth thinking about.

Mr. Innis—Now, I have been thinking considerably about this since the secretary sent me his proposition, and I don't think we could carry it out with less than 200 members. If we can get the 200 members we can raise money enough perhaps to go into an office here in the city and do as the secretary has pointed out. Wouldn't it be well to commence to try to do something? Cannot the secretary get up a paper, conditioned that when it is signed by 200 responsible names, that they would contribute $15 per annum each. I would not want to sign it if thirty or forty, or fifty only, or even one hundred should sign it, and be always hard up; but if 200 sign it, I will sign it.

Mr. Burgess—For my own information and others I would like to inquire upon what basis our assessment is made. Is this charge of $3 fixed by the constitution or determined by the trustees?

The President—You heard the report of the trustees a while ago.

Mr. Burgess—Yes sir, I noticed the peculiar reading and I supposed that was the situation, that the trustees fixed the assessment.

The President—That is the rule, that the trustees report each year a certain sum at which the annual dues are fixed, and I think it has invariably been $3.

Mr. Burgess—It certainly seems to me that that is a very small fee, considering the number of the exchanges that come to

the association, and I supposed it would have occurred to the members of the board of trustees to have placed that fee at a higher figure, perhaps five or six or eight or even ten dollars, with the expectation of paying our secretary for his services. It seems to me in that line there is a possible settlement of the question. I make this as a suggestion for the purpose of bringing out from the old members of the board of trustees any suggestions they have to make.

Mr. Bowen—Mr. Burgess' suggestion put an idea into my head, that it would be well enough, if the other project fails, to have the dues for the members fixed at a higher rate, of course the exact amount to be determined by the trustees. It is right and proper that they should do it, and our by-laws so provide. As Mr. Burgess stated, there is no question but the mere nominal fee of $3 per year is not any kind of an equivalent for what we get for it. There is not a single report that we get of our own, notwithstanding our members are here and hear the discussions and hear the papers read, but there has not been a single report printed within my recollection, these many years, but what is worth more than all he pays for it, to say nothing of the exchanges. I would not begin to sell my reports for $3 a piece, and I think I have them from the beginning of the society. It has been no sort of consideration. Now when you come to get four, or five, or six, or eight, exchanges that are quite as full of meat as these are, I think a man gets back full value for his money, and we could well afford to pay $5 or $8, or even $10, as Mr. Burgess states.

Mr. Innis—I just want to say, for the information of Mr. Bowen and others, that that report of the board of trustees was made fixing the dues of 1892 with the idea of running along in the way we have been running and getting the secretary to do the work without compensation, and we thought we could run along as we have been doing. If we want to go into anything more expensive, and if it is thought best to pay the secretary, the trustees would have to reconsider their report in the way of dues. Last year the $3 just about paid expenses. I think we ought not to ask any one to serve as secretary without compensation, for less than $400 or $500 a year. If it takes half his time, or in that proportion, it is certainly worth $200 or $300 to say the least. If that is so we ought to be taxed about $5 each.

The President—Mr. Dunn has made a motion to appoint a special committee, of which the secretary shall be one member, the committee to consist of three, I believe, who shall formulate

a plan and report to the society a plan under which the suggestions of the secretary can be carried out.

Mr. Bowen—What would be the scope of the duties of that committee ?

The President—To formulate a plan under which the plans of the secretary could be carried out, would require a change in the constitution, and require some definite plan of work. Of course the suggestions of the secretary are very full, and yet they come only as a report, and in our discussion of them, so far and in the future, it will simply be on the report, and we might go on to the end of the session and find we had discussed the report and come to a place where we considered the matter advisable, but have no plan formulated upon which we could act properly and intelligently. I think the suggestion a good one.

The question then coming upon the motion of Mr. Dunn it was declared carried.

Mr. Bowen—Now, Mr. President, I move the report of the trustees be referred back for further consideration.

The motion being seconded, was carried.

REPORT OF SPECIAL COMMITTEE ON PERMANENT SECRETARY.

The committee on permanent secretary respectfully report that: To carry out this idea will involve the necessity of a material change in the details of our work. A suite of office rooms in some suitable place, with office furniture, fuel and light, printing and stationery, the pay of the secretary, and possibly an assistant, will cost in round numbers, say $3,000 a year. To raise this much money at our present rate of assessment would require 1,000 members; at $5.00, would require 600 members; at $10.00, would require 300 members; at $15.00, would require 200 members.

The secretary has clearly stated what he proposed giving the members for their money, and we deem it a just equivalent for the greatest amounts stated, and believe it a step in the right direction, We therefore recommend that the plan for a permanent secretary be carried out, provided it meet the approval of a good majority of the members of the society, and no expense be incurred until the funds are guaranteed.

B. F. Bowen,
L. W. Mathewson,
E. D. Wileman.

$2. The report of the trustees was referred back, as those who were present at the time know, so that the trustees might take that matter into consideration and make a further report as to what was deemed necessary. We might be able to do as I have indicated, or in some such way, by paying a man $250 say, for the services rendered the society during the year for this year, and in the meantime we might ascertain, as far as possible, how many would be willing to go into the scheme proposed. If we could not get a full expression of the members of the society in any other way, we might take a ballot by means of sending ballots to all of the members and having them fill them out and return them by mail, and when we come together next year we would be able to discuss more intelligently the proposition of being able to carry out the project here suggested. I certainly believe that it would be a good thing. I know that we would each of us receive more value than what we would pay, and if it should bring to us the results which I think it would, then the view which I expressed in my address this morning might be accomplished, that all the men engaged in engineering and surveying within the State of Ohio would be drawn towards it, because we would be making our society of value and interest to them, and I hope that some one here will make a motion so that it may come before the house and that we may act upon it, that in the coming year we may pay the secretary for the labor of preparing the report and distributing the same, the sum, say of $250, more or less, as the society may determine.

On motion of Mr. Davisson the salary of the secretary for the ensuing year was fixed at $200.

Prof. Brown—In regard to this plan for a permanent secretary I think it is one of the very desirable things, but, on account of the small membership here, I think it is hardly advisable for us to do anything positive, or definite, one way or the other, but that information should be gathered, and we should find out how many members will go into this matter, and if there are enough to keep it up, then have some definite action taken at the next meeting.

Mr. Connar—Mr. President, I would like to get the sense of the members present, how they stand on a matter of that kind.

The President—I will ask that all the members present in the room—this is an informal vote, merely to test the feelings of those present—I would ask how many members would be willing to go into the scheme if 200 were secured. All those who would be willing please rise to their feet. There is a majority of those present standing on their feet.

Would any of those present and not voting for it be willing to go into it if 300 could be secured at $10 a year?

Gentlemen, it is very evident that so far as the members present are concerned, some such plan is desirable.

Mr. Connar—I move that the report be referred back to the committee.

Mr. Burgess—I would amend that by suggesting that they be instructed to try to secure, during the session, a letter ballot on that question. The amendment was accepted by Mr. Connar.

The question then coming on the motion of Mr. Connar, as amended, it was carried.

Prof. Brown—If the members are not too tired, I would like to ask a few questions in regard to some work I have been starting at the university in regard to cement tests. If it is the desire of the society to wait a few moments I would like to say that during the past year, and this one, I have been doing some work in testing cements. I have a testing machine of a capacity of about 1,000 pounds. We have been doing some work and I have got some pretty fair results, but there are some things bothering us and we have not got it worked out yet, and if there are any persons here working with cements, we would like to get some suggestions. We have been trying to follow the recommendations of the American society of civil engineers for testing cements. The principal trouble is the breaking up of the briquet in the clamps. Very near half of them will break there, and, as far as we can see, from no apparent reason. We have changed the shape of the clip a little bit, but as far as we can see from measurement and observation, there is no difference between the shape of the briquet as moulded and the shape of the clips. We have done a little work in putting in slips of paper or paste board. Now we are using the standard form of briquet adopted by the American society, and I would like to know if any of the other members have met with such trouble in testing cements, and I would also like to ask if any of the members have tried any of these machines for pounding the cements into the moulds, so as to get the briquet of the same density. Any information we can get will be valuable to us.

From the minutes of Thursday afternoon session:—

Mr. Bowen—I move that the society set apart $200 in payment of Mr. Wileman for the services he rendered during the past year.

Mr. Burgess—I second the motion.

Mr. Strawn—Mr. President, I most heartily want to second that, and I hope we will be more generous toward Mr. Wileman even than that if possible. I know something of the duties he has had to perform.

Secretary Wileman—Mr. President and members of the society, I hope this will not carry for this reason: in the first place the treasury cannot stand it. In its present condition it is in fair condition to carry the work through for the next year, but to do that would cripple it seriously, and as for a special assessment, I would not hear of it. Furthermore, I have given my time for the past year cheerfully, and feel the honor that has been conferred on me by it, and the $200 would not be a compensation for the work I have done at all. And I do not wish to belittle myself by receiving the $200 as a compensation for the services rendered.

Mr. Bowen—Now, Mr. Chairman, I do not want to be understood as fixing the amount of compensation at $200 as being the full measure of the value of the services. I simply put it at that figure because I understand that that is what the society have voted for the secretary during the next year. Now, the very least that we ought to do is to tender him as much as we proposed to tender the incoming secretary. After we have taken our action it is proper to express our good will in that kind of measure. I do not feel that it is just or that it is sufficient compensation to Mr. Wileman for the services he has rendered, but it is better than nothing. It shows the good will of the society towards our worthy secretary, and if he don't see proper to take it, it is very easy to let it remain in the treasury, that is after it gets there.

Mr. Burgess—I want to say that I cannot too heartily concur in what Mr. Bowen has said on this subject. I want to say in addition to what I said to some members of the society last evening in conversation. We are getting here $20 worth of exchanges for our $3 dues. We have been doing that for years past. We are getting a great deal more from our connection with this organization than it costs us. Now I say we could not exist without our secretary. Our secretary is our health and strength. We could get along without the president, we could almost get along without the executive committee, but as an organization, we could not have had an existence without the secretary, certainly not a successful existence. Every man here knows that to be a fact. I believe that it is certainly due to Mr. Wileman to treat him in the same manner that we propose to

treat our incoming secretary, and I am only sorry that we have not treated our secretaries in the past in the same manner.

The question then coming on the motion of Mr. Bowen it was carried.

The President—Is there any further business to come before the society ? If not, allow me to say that while I was not to have heard what was said by the committee on nominations in its report, yet for some reason my ears were open, I could not help it. I want to say that your president appreciates your kindness, but your thanks are much more due to your secretary. The president has done perhaps what he could in the most busy year of his life. But what he could do has been very little outside of attending the meetings and getting up the committees and such things. What the president could do has been very little, but I do know that what the secretary has done has been of immense value. I trust we shall all of us appreciate very fully the work of the secretary of the past year, that we shall remember him with gratitude, that we shall do whatever we can to show our appreciation of this in the future. Gentlemen, I hope that each one of us that are here, and in fact, the whole membership of the society, will use their greatest influence in pushing the bill which shall be presented to the legislature. It will take a good deal of pushing I expect, and everybody should do his part. I hope that we may all enjoy a successful and profitable year of labor, and that we shall meet at the end of the coming year with better prospects than we had at the beginning, and the prospects that we have now are by no means poor.

There being no further business before the meeting the thirteenth annual meeting of the Ohio Society of Surveyors and Civil Engineers will adjourn *sine die.*

STATE DIRECTORY OF SURVEYORS AND CIVIL ENGINEERS.

Names in Italics are Members of the Society.

Abernethy, C. F.,	S. and C. E.,	Circleville,	Pickaway.
Ackerman, L. B.	S. and C. E.,	Fredericktown,	Knox.
Acton, J. V.	S. and C. E.,	Eaton,	Preble.
Addy, M.	S. and C. E.,	Cincinnati,	Hamilton.
Agnew, W. C.	Chief Eng. L. A. & Mo. Ry.,	Youngstown,	Mahoning.
Alkire, H. F.	Surveyor,	Woodlyn,	Pickaway.
Ames, D. D.	S. and C. E.,	Bowling Green,	Wood.
Armicost, E	County Surveyor,	Greenville,	Darke.
Amsden, L. A.	S. and C. E.,	Ashtabula,	Ashtabula.
Anderson, L. A.	Civil Engineer,	Cincinnati,	Hamilton.
Applegate, W. S.	S. and C. E.,	Lancaster,	Fairfield.
Arey, C. O.	Civil Engineer,	Cleveland,	Cuyahoga.
Arnett, J.	S. and C. E.,	London,	Madison.
Arnott, J. S.	S. and C. E.,	Greenfield,	Highland.
Arnott, E.	S. and C. E.,	Greenfield,	Highland.
Atkinson, M. K.	Surveyor, Ass't C. C. E.,	Glouster,	Athens.
Atkinson, J. W.	S. and C. E.,	Galion,	Crawford,
Bachtell, S.	Civil Engineer,	Columbus,	Franklin.
Baird, E. C.	Civil Engineer,	Dayton,	Montgomery.
Baker, S. J.	Assistant C. C. E.,	Cleveland.	Cuyahoga.
Baker, R. L.	Surveyor,	Coshocton,	Coshocton.
Baldwin, W.	Professor of C. E.	Uni. of Cincinnati,	Hamilton.
Baldridge, F.	Surveyor,	Cherry Fork,	Adams.
Barber, C. M.	Civil Engineer,	Cleveland.	Cuyahoga.
Barker, F. M.	Surveyor,	Painesville,	Lake.
Barnes, G.	Surveyor,	Georgetown,	Brown.
Bashford, R. X.	Civil Engineer,	Canton,	Stark.
Bashore, F. W.	S. and C. E.,	Paulding,	Paulding.
Bashore, T. H. B.	S. and C. E.,	Paulding,	Paulding.
Beatty, J. G.	Dep. C. Surveyor,	Columbiana,	Columbiana.
Beebe, B. B.	Surveyor,	Marblehead,	Ottawa.
Beers, J.	S. and C. E.,	Greenville,	Darke.
Beightler, W. P.	Co. Surv'r and C. C. E.,	Marysville,	Union.
Bell, S.	Civil Engineer,	Marion,	Marion.
Bement, S.	Civil Engineer,	Toledo,	Lucas.
Bender, W. L.	Civil Engineer,	Canton.	Stark.
Benson, O.	Civil Engineer,	Canton,	Stark.
Beutley, R.	S. and C. E.,	Youngstown,	Mahoning.
Betts, C. H.	S. and C. E.,	Riverside,	Hamilton.
Biddison, E. G.	Co. Surv'r and C. E.,	Athens,	Athens.
Bill, H. W.	Civil Engineer,	Cleveland,	Cuyahoga.
Binkerd, O. W.	Civil Engineer,	Dayton,	Montgomery.
Binkerd, J. S.	Civil Engineer,	Dayton,	Montgomery.
Bishop, C. D.	Civil Engineer,	Cleveland,	Cuyahoga.
Bishop, W. C.	Surveyor,	Batavia,	Clermont.
Blair, A. Z.	Surveyor,	West Union,	Adams.
Bliss, A. L.	S. and C. E.,	Northfield,	Summit.

Boalt, E. E.	Assistant C. C. E.,	Cleveland,	Cuyahoga.
Bodette, G. H.	Civil Engineer,	Toledo,	Lucas.
Bone, E. A.	City Eng. & Co Surveyor,	Lebanon,	Warren.
Booth, J. B.	S. and C. E.,	New Philadelphia,	Tuscarawas.
Bouscaren, L. K. G.	M. A. S. C. E.,	Cincinnati,	Hamilton.
Bowen, B F.	S. and C. E ,	Columbus,	Franklin
Bower, A. M.	S. and C. E.,	Lebanon,	Warren.
Braly, J M	Civil Engineer,	Canton,	Stark.
Braun, W.	Civil Engineer,	Columbus,	Franklin.
Brenneman, S. M.	Surveyor,	Orrville,	Wayne.
Brennen, E. B.	Civil Engineer.	Port Clinton,	Ottawa.
Brett, B	S. and C. E.,	Geneva,	Ashtabula.
Brown, A E.	Civil Engineer,	Cleveland,	Cuyahoga.
Brown, J. F.	County Surveyor,	Cleveland,	Cuyahoga.
Brown, C. N.	Prof C. E , O. S. Uni'y,	Columbus,	Franklin.
Brown, F	S. and C. E.,	Bellefontaine,	Logan
Brown, J. R. C.	S. and C E.,	Ironton,	Lawrence,
Brown, J , jr.	Surveyor,	Put-in-Bay,	Erie.
Brown, J. D.	Surveyor,	Payne,	Paulding.
Brown, W P.	Civil Engineer,	Cleveland,	Cuyahoga.
Brown, W	Pn B C E.,	Cleveland,	Cuyahoga.
Bryan, R. A.	Surveyor and C. C. E ,	Portsmouth,	Scioto.
Buck, J. T	Civil Engineer,	Cardington,	Morrow.
Buell, C W.	S. and C. E.,	Toledo,	Lucas.
Buell, E. W.	Acting C. C. E.,	Marietta,	Washington.
Buell, ——	Surveyor,	Gustavus,	Trumbull.
Burgess, C. H	S. and C. E.,	Cleveland,	Cuyahoga
Burke, M. D.	Civil Engineer,	Cincinnati,	Hamilton.
Burton, C.	Chief Eng. T. & O. C Ry., and others.	Toledo,	Lucas
Caldwell, J. N	Assistant U. S. C. E.,	Cincinnati,	Hamilton.
Calhoun, J C.	Surveyor,	Millersburg,	Holmes.
Campbell, J W.	Surveyor,	Hollowtown,	Highland.
Campbell, R.	Surveyor,	Georgetown,	Brown.
Canfield, J W.	Surveyor,	Canfield,	Mahoning.
Carpenter, E	Ass't U S. Engineer,	Cincinnati,	Hamilton.
Carlisle, J.	Civil Engineer,	Cincinnati,	Hamilton.
Carnahan, W.	Surveyor,	Coshocton,	Coshocton.
Carl, A.	Surveyor,	Henking,	Gallia.
Cassel, A.	C. C. Engineer,	Mt. Vernon,	Knox.
Cassel, H. H.	Civil Engineer,	Mt. Vernon,	Knox.
Casselman, L. H.	Surveyor,	Carrollton,	Carroll.
Cellarius, F. J.	Ass't C C Engineer,	Dayton,	Montgomery.
Chadman, G S.	S. and C E.,	Conneaut,	Ashtabula.
Chapin, L. E	C. C. E..	Canton,	Stark.
Chandler, C. C.	Ch. E. M. of W O. & M. Ry.,	Cincinnati,	Hamilton.
Chapman, W. D.	Surveyor,	Akron,	Summit.
Clark, W. P.	Surveyor,	Medina.	Medina
Clevenger, P	Surveyor,	Wilmington,	Clinton
Cole, J	County Surveyor,	Ravenna,	Portage.
Connar, T C.	S. and C E ,	Zanesville,	Muskingum.
Converse, J.	S and C E.,	Plain City,	Madison.
Cook, J. D	Sanitary Engineer,	Toledo,	Lucas.
Cookston, C. G.	S. and C. E.,	Belle Centre,	Logan.
Coryell, W. L.	S. and C. E.,	West Union,	Adams.
Coryell, J. L.	Surveyor,	West Union,	Adams
Counts, C.	County Surveyor,	Port Jefferson,	Shelby.
Counts, I	Surveyor,	Peoli,	Tuscarawas.
Cowles, W. L.	Chief Eng Youngstown Bridge Works,	Youngstown,	Mahoning.
Coverdale, R. T.	S. and C. E.,	Cincinnati,	Hamilton.

3.	S. and C. E.,	Wapakoneta,	Auglaize.
k.	Surveyor,	McArthur,	Vinton.
'd, J. A.	Surveyor,	New Petersburg,	Highland.
T.	Surveyor,	East Hamilton,	Butler.
', J. C.	County Surveyor,	Lima,	Allen.
J. L	Civil Engineer,	Cleveland,	Cuyahoga.
gham, R. A.	Surveyor,	Zanesville,	Muskingum.
H. S.	Surveyor,	Bellefontaine,	Logan.
E. F.	Surveyor,	Nashville,	Holmes.
port, E. C.	Ass't C. E. B. & O. R. R.,	Zanesville,	Muskingum.
J.	S. and C. E.,	Columbus,	Franklin.
I. B.	Civil Engineer,	Cleveland,	Cuyahoga.
S,	S. and C. E.,	Weston,	Wood.
M. L.	Civil Engineer,	New Lisbon,	Columbiana.
C. S.	Civil Engineer,	Massillon,	Stark.
n, F. M.	Surveyor,	West Manchester,	Preble.
ı, C.	County Surveyor,	Bellaire,	Belmont.
l, J. M.	County Surveyor,	Celina,	Mercer.
on, L. B.	Surveyor,	Delaware,	Delaware.
O. E.	Civil Engineer,	Port Clinton,	Ottawa.
I. B.	Chief Eng. Z. & O. Ry.,	Zanesville,	Muskingum.
, H. L.	S. and C. E.,	Greenfield,	Highland.
', S. F.	C. C. E.,	Warren,	Trumbull.
on, L. A.	C. C. E.,	Fremont,	Sandusky.
. S.	Surveyor,	Delaware,	Delaware.
L. A.	Civil Engineer,	Hamilton,	Butler.
:, E. W,	Surveyor,	Ottawa,	Putnam.
W. S.	Surveyor,	Winchester,	Adams.
L. W.	Civil Engineer,	Zanesville,	Muskingum.
dge, P.	Civil Engineer,	Coshocton,	Coshocton.
F.	Civil Engineer,	Middletown,	Butler.
m, D.	County Surveyor,	Lindale,	Clermont.
r. J. W.	Surveyor,	Cowington,	Miami,
n, J. F.	County Surveyor,	McConnellsville,	Morgan.
P. H.	Surveyor,	Logan,	Hocking.
'all, L. R.	S. and C. E.,	Hilsboro,	Highland.
ı, R. R.	Co. Surv'r and C. E.,	Upper Sandusky,	Wyandot.
I. J.	Co. Surv'r and C. E.,	Columbus,	Franklin.
ım, H. F.	Civil Engineer,	Cleveland,	Cuyahoga.
Wm.	C. E. and Dep. Co. Surv'r.,	Zanesville,	Muskingum.
r, J. B.	Pres. W. Reserve Normal Col., S. and C. E.,	Wadsworth,	Medina.
on, J. T.	Co. Surv'r and C. E.,	Ironton,	Lawrence.
ndstone, G. S.	Civil Engineer,	Defiance,	Defiance.
man, John	Civil Engineer,	Cleveland,	Cuyahoga.
lge, W.	Co. Surv'r and C. E.,	Marietta,	Washington.
J.	Surveyor,	Vinyard Hill,	Adams.
J.	Surveyor,	Aberdeen.	Brown.
ondson, G. S.	Civil Engineer,	Defiance,	Defiance.
, R. L.	C. E. L. & J. Bridge Co.,	Cincinnati,	Hamilton.
on, D. H.	Surveyor,	Defiance,	Defiance.
on, G. E.	Eng. M. of W. C. & M. V. Ry.,	Zanesville,	Muskingum.
ı, W. R.	Surveyor,	Gallia Furnace,	Gallia.
g, C. A.	S. and C. E.,	Cincinnati,	Hamilton.
er. I. P.	Surveyor,	New Lisbon,	Columbiana.
r, G. W.	S. and C. E.,	Williamsburg,	Clermont.
ın, B. W.	Chief Eng. F. F. W. & W. Ry.,	Findlay,	Hancock.
s, H. C.	Ass't Eng. T. C. & C. Ry.,	Toledo,	Lucas.
er. E. A.	Civil Engineer,	Chardon,	Geauga.
augh, A. W.	S. and C. E.,	Celina,	Mercer.

Fisher, J. D.	Civil Engineer,	Zanesville,	Muskingum.
Fisher, L.	Civil Engineer,	Akron,	Summit.
Fisher, J. L.	S. and C. E.,	Tiffin,	Seneca.
Fite, A.	Surveyor,	Georgetown,	Brown.
Fitzpatrick, A.	Surveyor,	Fayetteville,	Brown.
Force, C. G.	C. C. E.,	Cleveland,	Cuyahoga.
Foster, T. P.	S. and C. E.,	Bentonville,	Adams.
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